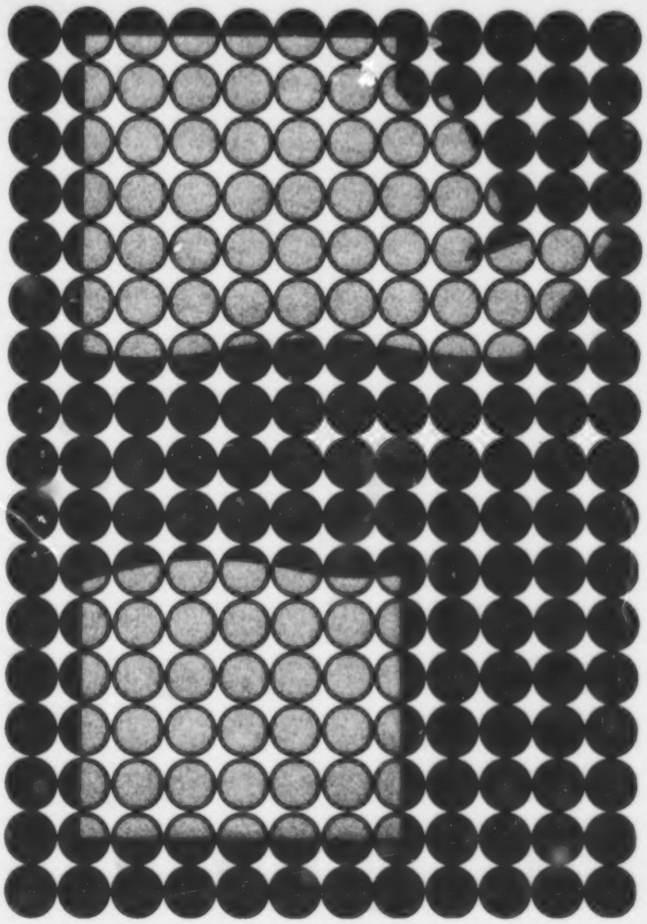


CANADA — MANITOBA
Soil Survey

Soils of the Towns of Fraserwood, Inwood, Komarno and a strip of the Lake Manitoba Shoreline

Report D-57

Government of Canada
Gouvernement du Canada
Government of Manitoba
Gouvernement du Manitoba

SOILS REPORT NO. D57 1986

Soils of the Towns of Fraserwood, Inwood, Komarno and a strip of the Lake Manitoba Shoreline

by

Glenn Podolsky

CANADA-MANITOBA SOIL SURVEY

AGRICULTURE CANADA

MANITOBA DEPARTMENT OF AGRICULTURE

DEPARTMENT OF SOIL SCIENCE, UNIVERSITY OF MANITOBA

PREFACE

This report and map of the detailed field and laboratory study of the soils of the Fraserwood, Inwood, Komarno and Lake Manitoba Shoreline area are one in a new series of such soil survey reports covering special interest areas in southern Manitoba. These reports reflect the growing concern by various government agencies that support the Canada-Manitoba Soil Survey, that a knowledge of the development and distribution of the soils of Manitoba is the key to understanding their properties, behavior and response to management. This concern requires that soils be described both in terms of their basic properties and the nature of the environmental setting in which they are found. Thus, when an area such as that in the study requires delineation of land of high or low value for crop production or for other uses, the basic reference document is an accurate and reliable soil map.

The land resource information included in this resurvey covers approximately 1 856 ha of land in the vicinity of Fraserwood, Inwood, Komarno and the Lake Manitoba Shoreline. It covers only a fraction of the area covered in the former reconnaissance survey of the Fisher and Teulon Map Sheet Areas, (Report No. 12, 1961). However, the projected more intensive use of the soils for agriculture and the growing competition for other uses of land in the area has created a need for more up-to-date, more accurate and more detailed soil information. The increased examination of soils in the field, the use of current aerial photography, the use of improved methods of studying soils in the laboratory and the accumulated knowledge of the properties and uses of soils over the years, have all contributed to the additional information contained in this new series of reports and maps.

During the course of the resurvey of the study area, a large volume of site specific data for the soils mapped in the area was generated, that for practical reasons cannot be included in this interim report. These data are currently being input into the Canada Soil Information (CanSIS) data bank. This computerized system of data management permits automated manipulation and statistical evaluation of large volumes of data for soil characterization and interpretations. These data will shortly be available on request. In addition, the cartographic file of CanSIS provides a capability to produce derived maps of various kinds quickly and inexpensively. The types of derived maps that can be generated from the basic soil map include the sixteen interpretations that are provided in tabular form in this report as well as a number of single feature maps for such characteristics as drainage, texture of surface deposits, slope, stoniness, distribution of salinity, etc. A package of interpretive maps and single feature derivative maps can be made available in request to: The Canada-Manitoba Soil Survey, Dept. of Soil Science, Rm. 362, Ellis Bldg., University of Manitoba, Winnipeg, R3T 2N2

The Canada-Manitoba Soil Survey trusts that this report and accompanying map will be of value to all individuals and agencies involved with the use of land within the map area.

ACKNOWLEDGEMENTS

The report on the Soils of the Towns of Fraserwood, Inwood, Komarno and the Lake Manitoba Shoreline was initiated in response to a request from the Department of Municipal Affairs and conducted as a joint project of the Manitoba Department of Agriculture and the Canada Department of Agriculture.

Grateful acknowledgement is made to the following persons:

R.E. Smith, Director of the Canada-Manitoba Soil Survey for reviewing the manuscript.

J. Griffiths and R. DePape for preparation of maps and sketches.

M. Brown, for inputting the maps into the CanSIS cartographic file.

D. Sandberg for typing and assisting preparation of the report.

J. Madden, E. St. Jacques, R. Mirza and J. Yeung for laboratory analyses, carried out under the supervision of P. Haluschak.

The field work was carried out by G.P. Podolsky, assisted by G. Martin.

HOW TO USE THIS SOILS REPORT

This soils report contains considerable information about the soils, their origin and formation, their classification and their potential for various uses such as dryland agriculture, irrigation, engineering and recreation. The report is divided into four parts: Part I provides a general description of the area; Part 2 describes the methodology used in the study; Part 3 discusses the development, scientific classification and morphological characteristics of the soils in the study area, and Part 4 provides an interpretation of soil properties and associated landscape features as they affect soil capability or suitability for various uses.

The soil map of the study area is compiled on an uncontrolled air photo base which is included in a pocket of the report folder. The map shows the distribution of soil types and associated landscape features that are significant for potential use as field management units. It provides a linkage from landscapes within the study area to the information contained in the report.

To assist the user in retrieving soil information quickly, the following steps are suggested:

If project consists of many individual maps, proceed with STEP 1., if only single map in pocket, proceed with STEP 2 to 6.

STEP 1 Consult the index to map sheets if the report contains many maps. Locate the areas of interest and note the map-sheet number(s) which identify the township and range on each map.

STEP 2 Consult the soil map in pocket of report folder. Locate the area(s) of interest on the map and identify the pertinent map unit symbols. Arabic numerals placed as superscripts following map symbols indicate the approximate proportion of each soil type within the map unit.

STEP 3 Consult the extended legend accompanying the soil map for an alphabetical listing of soil symbols giving the soil name, classification, drainage and related information concerning landforms, nature and depth of materials, and dominant vegetation.

STEP 4 For interpretive information about the soils, consult the appropriate Table in Part 4. Criteria utilized as guidelines in making these interpretations are provided in the Appendix.

STEP 5 Further information concerning the morphological properties and extent of the soils is presented in Part 3 where the soils are described alphabetically according to soil name.

STEP 6 Additional site-specific information not contained in this report is available on request from the Canada-Manitoba Soil Survey, Ellis Building, University of Manitoba.

SUMMARY OF SOIL SURVEY COVERAGE FOR MANITOBA
JANUARY, 1986

Map Project Designation	Name (Soil Report No.)	Report[1] Status	Area in Hectares	Map Unit[2] Description	Survey[3] Intensity Level	Map Scale	Map[4] Base	Land Evaluation[5] & Interpretations
Detailed Studies and Surveys								
D1	Pasquia (No. 11)	Pub. 1960	57 200	a,b,d	3	1:63,360	Color	A
D2	Glenlea Research Station	Int. 1963	541	a,b	1	1:7,920	Photo	A
D3	Morden Experimental Farm	Int. 1961	256	a,b	1	1:12,000	Photo	A
D4	Onanole	Int. 1968	768	a,b	1	1:7,920	Photo	U
D5	York Factory Area	Int. 1969	768	a	3	1:63,360	B&W	
D6	McCreary Tile Drain Project	Int. 1971	64	a,b	1	1:5,000	B&W	A
D7	Brandon Experimental Farm	Int. 1985	768	a,b	1	1:7,920	Photo	A
D8	Portage Potato Farm	Int. 1972	480	a,b	1	1:4,800	Photo	A
D9	Portage la Prairie (No. 17)	Pub. 1972	113 200	a,b,c	2	1:20,000	Photo	A,I,E,U,R
D10	Morden-Winkler (No. 18)	Pub. 1973	71 424	a,b,c	2	1:20,000	Photo	A,I,E,U,R
D11	Deep Lake	Int. 1975	1 400	a,b	1	1:6,000	B&W	R
D12	Thompson Environmental Study	Int. 1976	32	a,b	1	1:1,000	B&W	
D13	Organic Soil Study of Alexander L.G.D.	Int. 1975	29 456	a,b	3	1:63,360	B&W	A
D14	Winnipeg Region	Pub. 1975	280 000	a,b,c	2	1:20,000	Photo	A,E,U,R
D15	Brandon Region	Pub. 1976	59 600	a,b,c	2	1:20,000	Photo	A,E,U,R
D16	Boissevain-Melita (No. 20)	Pub. 1978	262 912	a,b,c	2	1:20,000	Photo	A,I,E,U,R
D17	Carman	Pre.	73 905	a,b	2	1:20,000	B&W	A,E,R
D18	Orr Lake	Int. 1977	20	a,b	1	1:1,000	B&W	
D19	Pelican-Rock Lake	Int. 1983	14 080	a,b	2	1:20,000	Photo	A,E,R,I
D20	West Portage	Int. 1982	120 956	a,b	2	1:20,000	Photo	A,I,E,R
D21	Minnewasta	Int. 1978	2 560	a,b	2	1:20,000	Photo	A,E,R,I
D22	Killarney	Int. 1979	4 600	a,b	2	1:20,000	Photo	A,E,R,I
D23	Matlock-Gimli-Riverton	Int. 1981	18 400	a,b	2	1:20,000	Photo	A,E,R,I
D24	Glenboro	Int. 1979	5 960	a,b	2	1:20,000	Photo	A,E,R,I
D25	Sandy Lake	Int. 1980	1 720	a,b	2	1:20,000	Photo	A,E,R,I
D26	Brokenhead	Int. 1979	10 813	a,b	2	1:20,000	Photo	A,E,R,I,U
D27	Rockwood	Int. 1980	12 928	a,b	2	1:20,000	Photo	A,E,R,I,U
D28	Oak Lake	Int. 1979	1 293	a,b	2	1:20,000	Photo	A,I
D29	Bird River	Int. 1980	2 560	a,b	2	1:20,000	Photo	A,E,R
D30	North Shore Lac du Bonnet	Int. 1980	2 400	a,b	2	1:20,000	Photo	A,E,R
D31	Grindstone Point	Int. 1979	8 040	a,b	2	1:20,000	Photo	A,E,R

SUMMARY OF SOIL SURVEY COVERAGE FOR MANITOBA (continued)
JANUARY, 1986

Map Project Designation	Name (Soil Report No.)	Report[1] Status	Area in Hectares	Map Unit[2] Description	Survey[3] Intensity Level	Map Scale	Map[4] Base	Land Evaluation[5] & Interpretations
D32	Paint Lake	Int. 1980	2 880	a,b	2	1:10,000	Photo	A,E,R
D33	Cranberry Portage	Int. 1980	80	a,b	1	1:5,000	Photo	A,E,R
D34	Dauphin	Int. 1981	6 400	a,b	2	1:20,000	Photo	A,E,R,I
D35	South Riding Mtn.	Pre.	23 488	a,b	2	1:20,000	Photo	A,E,R
D36	West Interlake	Int. 1981	10 036	a,b	2	1:20,000	Photo	A,E,I,R
D37	Swan R. Townsite	Pre.	7 680	a,b	2	1:20,000	Photo	A,E,R,I
D38	Hadashville-organic	Int. 1981	6 475	a,b	3	1:40,000	Photo	A,E,I,R
D39	Part of L.G.D. Stuartburn (Rat River)	Pre.	27 972	a,b	3	1:40,000	Photo	A,E,I,R
D40	Falcon L-Brereton L	Pre.	25 900	a,b	2	1:20,000	Photo	A,E,R
D41	Quesnel Lake-North Shore Winnipeg River	Pre.	3 000	a,b	2	1:20,000	Photo	A,E,R
D42	Duck Mountain	Int. 1982	3 036	a,b	2	1:20,000	Photo	A,E,R
D43	Spruce Woods	Pre.	26 300	e	3	1:40,000	Photo	A,E,R
D44	McGregor	Int. 1982	3 910	a,b	2	1:20,000	Photo	A,E,R
D45	Pine Creek	Int. 1983	1 942	a,b	2	1:20,000	Photo	A,E,R,I
D46	Arborg-Riverton	Int. 1982	2 590	a,b	2	1:20,000	Photo	A,E,R,I
D47	Roblin	Int. 1983	4 096	a,b	2	1:20,000	Photo	A,E,R,I
D48	Flin Flon	Pre.	4 600	a,b	2	1:20,000	Photo	A,E,R
D49	St. Anne-La Broquerie	Pre.	74 592	a,b	3	1:40,000	Photo	A,E,R,I
			4 662	a,b	2	1:20,000	Photo	A,E,R,I
D50	City of Brandon	Int. 1984	2 980	a,b	2	1:20,000	Photo	A,E,R,I
D51	Westbourne	Int. 1985	51,456	a,b	2	1:20,000	Photo	A,E,R,I
D52	Notre Dame, Rathwell, Treherne Townsites	Int. 1984	6 144	a,b	2	1:20,000	Photo	A,E,R,I
D53	Altona, Emerson, Gretna, Ile des Chenes, Landmark, Letellier, Rosenort, St. Jean Townsites	Int. 1984	14 080	a,b	2	1:20,000	Photo	A,E,R,I
D54	Russell, Binscarth-Townsites	Int. 1984	3 584	a,b	2	1:20,000	Photo	A,E,R,I
D55	St. Rose Du Lac-Townsite	Int. 1985	1 536	a,b	2	1:20,000	Photo	A,E,R,I
D56	Souris, Wawanesa, Virden, Townsites	Int. 1986	6 400	a,b	2	1:20,000	Photo	A,E,R,I
D57	Fraserwood, Inwood, Komarno Townsites, Lake Man. Shoreline	Int. 1986	1 856	a,b	2	1:20,000	Photo	A,E,R,I
D58	Hallboro, Minnedosa-Townsites	Int. 1984	4 544	a,b	2	1:20,000	Photo	A,E,R,I
D59	Beaudry Park	Data	640	a,b	2	1:20,000	Photo	A,E,R
D60	Portions of Dufferin, Grey, and Roland	Data	68 488	a,b	2	1:20,000	Photo	A,E,R,I
D61	Meditation Lake	Data	3 072	a,b	2	1:20,000	Photo	A,E,R
D62	Wanipigow Lake	Data	8 960	a,b	2	1:20,000	Photo	A,E,R

SUMMARY OF SOIL SURVEY COVERAGE FOR MANITOBA (continued)
JANUARY, 1986

Map Project Designation	Name (Soil Report No.)	Report[1] Status	Area in Hectares	Map Unit[2] Description	Survey[3] Intensity Level	Map Scale	Map[4] Base	Land Evaluation[5] & Interpretations
D63	Shellmouth Resevoir-N	Data	4 650	a,b	2	1:20,000	Photo	A,E,R,I
D64	Assiniboine River	Pre.	4 095	a,b	2	1:20,000	Photo	A,E,R,I
D65	Villages of Hamiota, Strathclair, Rapid City, Newdale, Birtle, Shoal Lake	Pre.	5 180	a,b	2	1:20,000	Photo	A,E,R,I
D66	Springfield R.M.	Pre.	13 440	a,b	2	1:20,000	Photo	A,E,R,I
D67	St. Eustache, Springstein, Perimeter Strip, Brunkild, La Salle R.	Pre.	6 200	a,b	2	1:20,000	Photo	A,E,R,I
D68	Spruce Point Mine Area	Pub.	450	a,b	2	1:10,000	Photo	E,R
D69	Snow Lake	Data						
Reconnaissance Surveys								
R1	South Western (No. 3)	Pub. 1940	709 600	d	3	1:125,000	B&W	A
R2	South Central (No. 4)	Pub. 1943	967 600	d	3	1:125,000	B&W	A
R3	Winnipeg and Morris (No. 5)	Pub. 1953	1 419 200	d	3	1:125,000	Color	A
R4	Rossburn and Virden (No. 6)	Pub. 1956	1 372 400	d	3	1:125,000	Color	A
R5	Carberry (No. 7)	Pub. 1957	967 600	d	3	1:125,000	Color	A
R6	West-Lake (No. 8)	Pub. 1958	592 800	d	3	1:125,000	Color	A
R7	Grandview (No. 9)	Pub. 1957	689 200	d	3	1:125,000	Color	A
R8	Nelson River Basin (No. 10)	Pub. 1973	224 000	b	3	1:100,000	Color	A
R9	Fisher and Teulon (No. 12)	Pub. 1961	949 200	a,c	3	1:100,000	Color	A
R10	Swan River (No. 13)	Pub. 1962	316 000	a,c	3	1:125,000	Color	A
R11	South Eastern (No. 14)	Pub. 1964	749 200	a,c	3	1:125,000	Color	A,F
R12	Lac du Bonnet (No. 15)	Pub. 1967	764 800	a,c	3	1:125,000	Color	A,F,R
R13	Grahamdale (No. 16)	Pub. 1971	764 800	a,b	3	1:125,000	Color	A,F,U,R,E
R14	Red Rose-Washow Bay (No. 19)	Pub. 1975	704 400	a,b	3	1:125,000	Color	A,F
R15	Boissevain-Melita (No. 20)	Pub. 1978	299 520	a,b	2	1:40,000	Photo	A,I,E
R16	Ste. Rose (No. 21)	Pub. 1981	676 705	a,b	3	1:125,000	Color	A,I,R,E,F
R17	Waterhen (No. 23)	Pub. 1985	949 600	a,b	4	1:125,000	B&W	A,I,R,E,F
R18	Swan Lake	Data	599 200	a,b	3,4	1:125,000	B&W	A
R19	The Pas (No. 22)	Pub. 1982	791 700	a,b	4	1:125,000	Color	A,I,E,R,F
R20	Grand Rapids	Pre.	675 031	a,b	4	1:125,000	B&W	A
R21	Cormorant	Int. 1975	920 000	a,b	4	1:125,000	B&W	A
R22	Wekusko	Pre.	1 400 000	a,b	4	1:125,000	B&W	A
R23	Pointe du Bois	Data	740 000	a,b				
R24	Roseau River	Pub. 1977	45 200	a,b	3	1:63,360	B&W	A
R25	Red Deer Lake	Pub. 1966	34 860	a,b	2	1:31,680	Photo	A
R26	Cross Lake and Norway House	Pre.	615 200	a,b	4	1:125,000	B&W	A
R27	South Central - Escarpment	Pre.	107 744	a,b	2,3	1:40,000	Photo	A,E,R
R28	Pasquia Lake	Pub. 1984	2 330	a,b	3	1:50,000	B&W	A,E
R29	Lorne R.M.	Pre.	512	a,b	2	1:20,000	Photo	A,E,R,I
			4 608	a,b	2	1:20,000	Photo	A,E,R,I
			73 728	a,b	3	1:50,000	N.T.S.	A,E,R,I

SUMMARY OF SOIL SURVEY COVERAGE FOR MANITOBA (continued)
JANUARY, 1986

Map Project Designation	Name (Soil Report No.)	Report[1] Status	Area in Hectares	Map Unit[2] Description	Survey[3] Intensity Level	Map Scale	Map[4] Base	Land Evaluation[5] & Interpretations
R30	Benito	Pre.	18 432	a,b	3	1:50,000	Photo	A,E,R,I
R31	R.M. Woodlands	Pre.	9 980	a,b	3	1:50,000	Photo	A,E,R,I
R32	Whitemouth Peatland		10 240	a,b	3	1:50,000		
R33	R.M. Rockwood					1:125,000		
R34	R.M. South Norfolk	Pre.	7 936	a,b	3	1:50,000	N.T.S.	A,E,R,I
			2 304	a,b	2	1:20,000	Photo	A,E,R,I

SUMMARY OF SOIL SURVEY COVERAGE FOR MANITOBA (continued)
JANUARY, 1986

Map Project Designation	Name (Soil Report No.)	Report[1] Status	Area in Hectares	Map Unit[2] Description	Survey[3] Intensity Level	Map Scale	Map[4] Base	Land Evaluation[5] & Interpretations
Biophysical and Exploratory Surveys								
B1	Lake Winnipeg, Churchill & Nelson Rivers	Pub. 1973	3 600 000	e	4	1:250,000 1:50,000	B&W	
B2	Churchill Transportation Corridor	Data 1974	179 000	f	4	1:125,000	B&W	
B3	54C Hayes River	Int. 1976	1 370 300	f	4	1:125,000	B&W	
B4	54D Kettle Rapids	Int. 1976	1 370 300	f	4	1:125,000	B&W	
B5	52M Carrol Lake	Int. 1977	634 000	f	4	1:125,000	B&W	
B5	62P Hecla	Int. 1977	466 200	f	4	1:125,000	B&W	
B6	53D Deer Lake	Int. 1978	629 700	f	4	1:125,000	B&W	
B6	63A Berens River	Int. 1978	848 500	f	4	1:125,000	B&W	
B7	53M Knee Lake	Int. 1978	1 405 900	f	4	1:125,000	B&W	
B8	53L Oxford House	Int. 1978	1 441 100	f	4	1:125,000	B&W	
B8	63H Norway House	Data	540 800	f	4	1:125,000	B&W	
B9	SE 1/4 64A Split Lake	Int. 1979	342 400	f	4	1:125,000	B&W	
B9	63P Sipiwesk	Int. 1979	1 405 900	f	4	1:125,000	B&W	
B10	53E Island Lake	Pre.	1 286 900	f	4	1:125,000	B&W	
B11	63H Norway House	Data				1:125,000	MSS	
E1	Surface Deposits & Soils of Northern Manitoba	Int. 1963		g	5	1:1,267,000	B&W	
E2	Exploratory Terrain Study of Northern Manitoba and Southern Keewatin, N.W.T.	Int. 1974		g	5	1:1,000,000	B&W	

1.Report Status
Pub.-Published Report and Map
Int.-Interim Report and Map Available
Pre.-Preliminary Map and Legend Available
Data-Field Data Available Only

2.Map Unit Descriptions Code
a-single series and phases
b-series complexes defined as to proportion
c-series complexes undefined as to proportion
d-associations
e-biophysical units (materials and physiography)
f-biophysical units (associations & complexes of associations)
g-regional and local physiographic units

3.Survey Intensity Levels

Code	Name	Scale	Minimum Size Delineation(ha)	Inspection Density (Approx. range)
1	Very detailed	>1:12,000	<1.5	>1 per 3 ha
2	Detailed	1:12,000 to 1:40,000	1.5-16	1 per 3 to 50 ha
3	Semi-detailed	1:40,000 to 1:125,000	16 to 256	1 per 10 to 1 000 ha
4	Reconnaissance	1:125,000 to 1:250,000	256 to 625	1 per 100 to 110 000 ha
5	Exploratory	1:250,000 to 1:1,000,000	625 to 110 000	1 per 300 to 500 000 ha

4.Published Map Base Code

Photo-Photomosaic
B&W -Black and white line
Color-Colored line

5.Interpretations Code

A-Agriculture Capability
E-Engineering
F-Forestry
I-Irrigation Suitability
U-Urban Planning and Community Development
R-Recreation

TOTAL HECTARAGE COVERED

	1985	To Date
Initial Reconnaissance	---	18,619,436
Initial Detailed survey	1,554	18,014
Detailed Resurvey	123,029	1,970,192
Biophysical Survey	---	12,521,000

Published Reports, Maps, Interim Reports, available at a cost of $2.00 per copy (except for D20) from:

Queen's Printer,
Publications Branch,
Manitoba Archives Bldg.,
200 Vaughan St.,
Winnipeg, Manitoba R3C 1T5
Phone:945-3103

Detailed Surveys of Winnipeg Region and Brandon Region available at a cost of $6.00 each from:

Municipal Planning Branch
Manitoba Dept. of Municipal Affairs
1418-405 Broadway Ave.,
Winnipeg, Man., R3C 3L6
Phone: 945-2150

Biophysical Land Classification Maps and Reports available at a cost of $3.50 each from:

Surveys and Mapping Branch
Century Industrial Branch
989 Century Plaza
Winnipeg, Man., R3H OW4
Phone: 945-6666

Preliminary Map and other field data available from:

Canada-Manitoba Soil Survey Office,
Rm. 362 Ellis Bldg., University of Manitoba
Winnipeg, Man., R3T 2N2
Phone: 474-6115 or 474-6118

CONTENTS

PREFACE ii

ACKNOWLEDGEMENTS iii

HOW TO USE THIS SOILS REPORT iv

PART page

1. **GENERAL DESCRIPTION OF THE STUDY AREA** 1

   Location and Extent 1
   Land Use 1
   Geology 3
   Relief and Drainage 3
   Physiography 3
   Surface Deposits 10
   Climate 10
   Vegetation 11

2. **METHODOLOGY** 13

   Mapping 13
   Map Units 13
   Simple and Compound Map Units 14
   Sampling 15

3. **FORMATION, CLASSIFICATION AND MORPHOLOGY OF SOILS** 16

   Soil Development 16
   Description of Soil Series 17
      Aneda Series (AND) 22
      Beaverdam Series (BVR) 22
      Berry Island Series (BYD) 22
      Crane Series (CRN) 23
      Garrioch Series (GRH) 23
      Glenhope Series (GHP) 23
      Gunton Series (GUO) 23
      Inwood Series (IWO) 24
      Lundar Series (LUR) 24
      Marsh Complex (MHC) 25
      Meleb Series (MEB) 25
      Partridge Creek Series (PGE) 25
      Peguis Series (PGU) 26
      Piney Series (PIY) 26
      Pelan Series (PLN) 26

Sand Beaches (SDB) 27
Selina Series (SLN) 27
Sprague Series (SPG) 27
Stonewall Series (STW) 28

4. USE AND MANAGEMENT INTERPRETATIONS OF SOILS 29

Introduction 29
Soil Capability for Agriculture 29
Dryland Agriculture 29
Irrigation Suitability 35
Soil Suitability for Selected Engineering Uses 39
Definition of Soil Suitability Classes 39
Soil Suitability Subclasses 40
Guides for Assessing Soil Suitability 40
Soil Suitability for Selected Recreation Uses 41

Appendix page

A. CORRELATION OF SOILS IN THE FRASERWOOD, INWOOD, KOMARNO AND LAKE MANITOBA SHORELINE STUDY WITH SOILS OF THE (1961) FISHER-TEULON REPORT AREA 50

B. GUIDES FOR EVALUATING SOIL SUITABILITY FOR SELECTED USES 53

C. GLOSSARY 69

D. SOIL HORIZON DESIGNATIONS 84

ORGANIC HORIZONS 84
MASTER MINERAL HORIZONS 85
LOWER-CASE SUFFIXES 85

E. DESCRIPTION OF LANDFORMS 91

GENETIC MATERIALS 91
Unconsolidated mineral component 91
Qualifying Descriptors 92
Organic component 92
GENETIC MATERIAL MODIFIERS 93
Particle size classes for unconsolidated mineral materials 93
Fiber classes for organic materials 94
SURFACE EXPRESSION 94
Consolidated and Unconsolidated mineral surface classes 94
Organic surface classes 95

F. DETAILED SOIL DESCRIPTIONS OF TWO SELECTED PROFILES SAMPLED WITHIN THE STUDY AREA 96

G. SOIL LEGEND 102

H. SYMBOLOGY 103

LIST OF TABLES

Table page

1. Summary of Survey Coverage for Manitoba vi
2. Soil Series of the Towns of Fraserwood, Inwood, Komarno and the Lake Man. Shoreline Arranged in Relation to Soil Moisture Class, Subgroup and Parent Material 18
3. Parent Materials and Related Soils of the Study Area 19
4. Agricultural Capability Subclass Limitations 33
5. Agricultural Interpretations of Soils in the Study Area 37
6. Codes utilized to identify limitations in evaluating soil suitability for selected Engineering and Recreational Uses(Tables 8 and 9) 42
7. Engineering Description of the Soils and Their Estimated Properties Significant to Engineering 43
8. Suitability Ratings and Limitations for Soils in the Study Area for Selected Engineering Uses 46
9. Suitability Ratings and Limitations of Soils in the Study Area for Various Recreational Uses 48
10. Correlation of Soils in the Study Area with Soils of the Detailed-Reconnaissance Soil Survey of the Fisher and Teulon Map Sheets (1961) 51
11. Land Classification Standards for Irrigation Suitability 54
12. Guide for assessing soil suitability as source of topsoil 55
13. Guide for assessing soil suitability as source of sand and gravel . . 56
14. Guide for assessing soil suitability as source of roadfill 57
15. Guide for assessing soil suitability for permanent buildings 58
16. Guide for assessing soil suitability for local roads and streets . . . 59

17. Guide for assessing soil suitability for trench type sanitary landfills 60

18. Guide for assessing soil suitability for area-type sanitary landfills 61

19. Guide for assessing soil suitability as cover material for area-type sanitary landfills 62

20. Guide for assessing soil suitability for reservoirs and sewage lagoons 63

21. Guide for assessing soil suitability for septic tank absorption fields 64

22. Guide for assessing soil suitability for playgrounds 65

23. Guide for assessing soil suitability for picnic areas 66

24. Guide for assessing soil suitability for camp areas 67

25. Guide for assessing soil suitability for paths and trails 68

LIST OF FIGURES

Figure page

1. Location of Study Area 2

2. Geology of Study Area 4

3. Principal Relief and Drainage of Study Area 5

4. Physiographic subdivisions in the area 9

5. Climate of Study Area 12

6. Family particle-size classes 83

7. Soil Textural Classes 83

PART 1

GENERAL DESCRIPTION OF THE STUDY AREA

1.1 LOCATION AND EXTENT

The areas involved in the study are located in the southern part of the Interlake Region of Manitoba. The area covered in this detailed resurvey is approximately 1 856 hectares. Fraserwood and Inwood are in the Local Government District of Armstrong, Komarno borders Armstrong and Rockwood, while the portion of the Lake Manitoba Shoreline is within the Rural Municipality of Woodlands, Figure 1.

This project is a resurvey of a part of the area formerly covered in the reconnaissance survey of the Teulon Map Sheet (Report No. 12, 1961) at a scale of 1:100,000. The current resurvey was carried out at a scale of 1:20,000. A summary of soil survey coverage for Manitoba is provided in Table 1.

1.2 LAND USE

The present land use throughout the study area is primarily agriculture. Mixed farming predominates, with livestock, some grain and forage production. The areas are best suited to mixed farming and livestock, since adverse conditions of stoniness and poor drainage render the land unfavorable for extensive grain production. However, some of the more suitable lands are being cleared, drained and cultivated for grain, improved pasture and forage production while the remainder is used for native grazing and woodland pasture.

A sharp contrast in land use occurs in the Lake Manitoba Shoreline portion of the study. Here, recreation is the preferred and recommended land use as soils in this area have little agricultural value. A cottage area is concentrated along the shoreline on the sand ridges. The beaches and shoreline provide excellent facilities for swimming, picnicking, boating and fishing. This type of area presents a very desirable and contrasting setting for cottaging by urban dwellers.

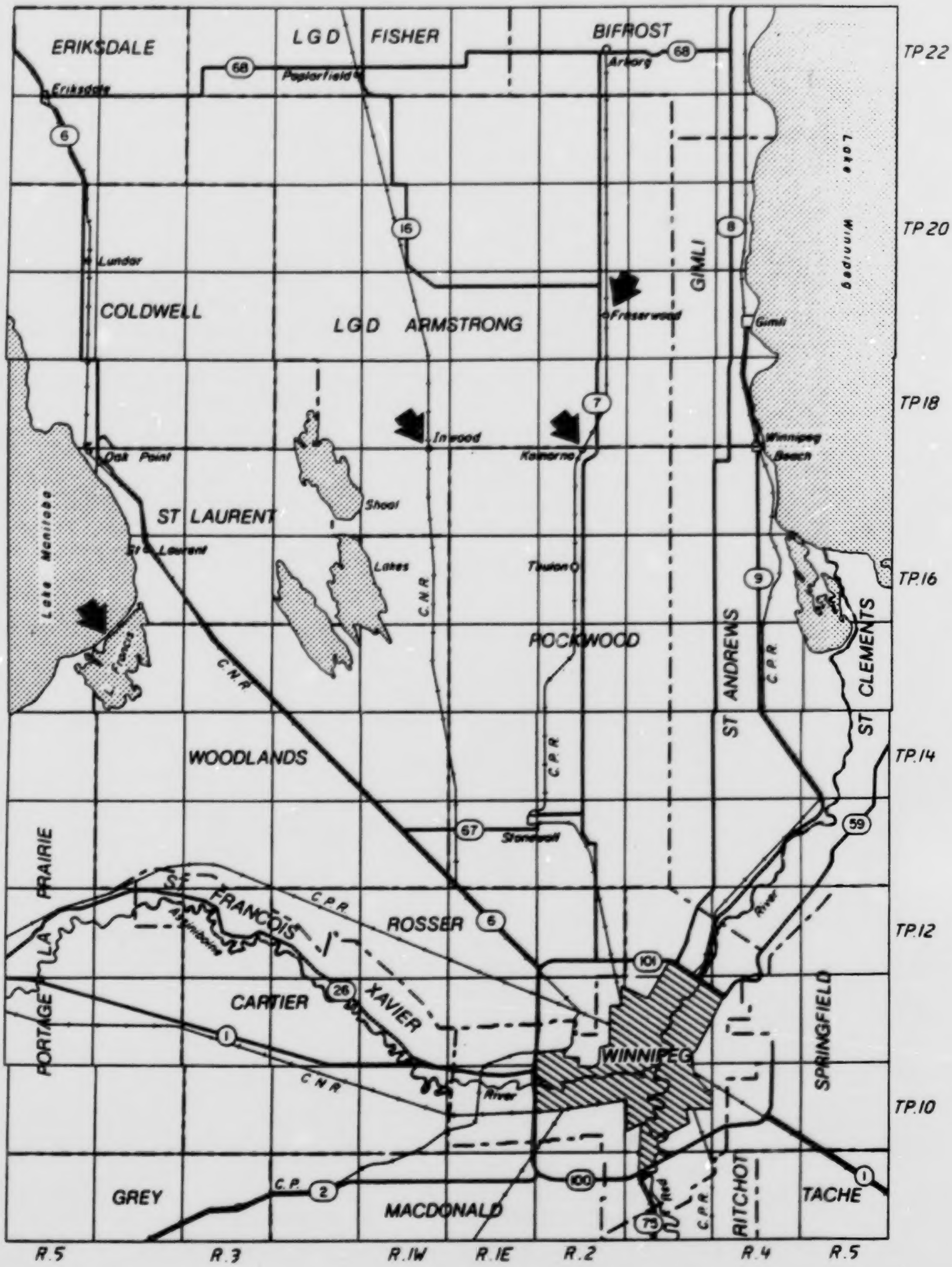

ERIKSDALE
LGD
FISHER
BIFROST
TP 22
68
Eriksdale
Poplarfield
Arborg
6
Lake Winnipeg
TP 20
16
8
Lundar
GIMLI
Fraserwood
COLDWELL
LGD ARMSTRONG
Gimli
TP 18
7
Inwood
Komarno
Winnipeg Beach
Oak Point
Shoal
ST LAURENT
Lake Manitoba
St. Laurent
Lakes
Teulon
TP 16
9
C.N.R.
L. Francis
ROCKWOOD
ST ANDREWS
C.P.R.
ST CLEMENTS
C.N.R.
WOODLANDS
C.P.R.
TP 14
67
Stonewall
59
PORTAGE LA PRAIRIE
ST FRANCOIS XAVIER
C.P.R.
Assiniboine
ROSSER
6
River
TP 12
101
CARTIER
26
1
WINNIPEG
SPRINGFIELD
C.N.R.
River
TP 10
100
1
GREY
C.P.
2
MACDONALD
Red
C.P.R.
RITCHOT
TACHE
75
R.5
R.3
R.1W
R.1E
R.2
R.4
R.5

Figure 1: Location of Study Area

1.3 GEOLOGY

Bedrock formations of the study area are outlined in Figure 2. The Lake Manitoba Shoreline portion of the study is underlain by limestone, dolomite and dolomitic shale of the Devonian Period. At Inwood, where bedrock occurs within a meter of the surface, the rock is limestone and dolomite of the Silurian Period. Dolomites of the Stonewall and Stony Mountain Formations, Ordovician Period, underlie the Komarno area. The rock types of the Fraserwood section are dolomites and limestone of the Red River Formation within the Ordovician Period.

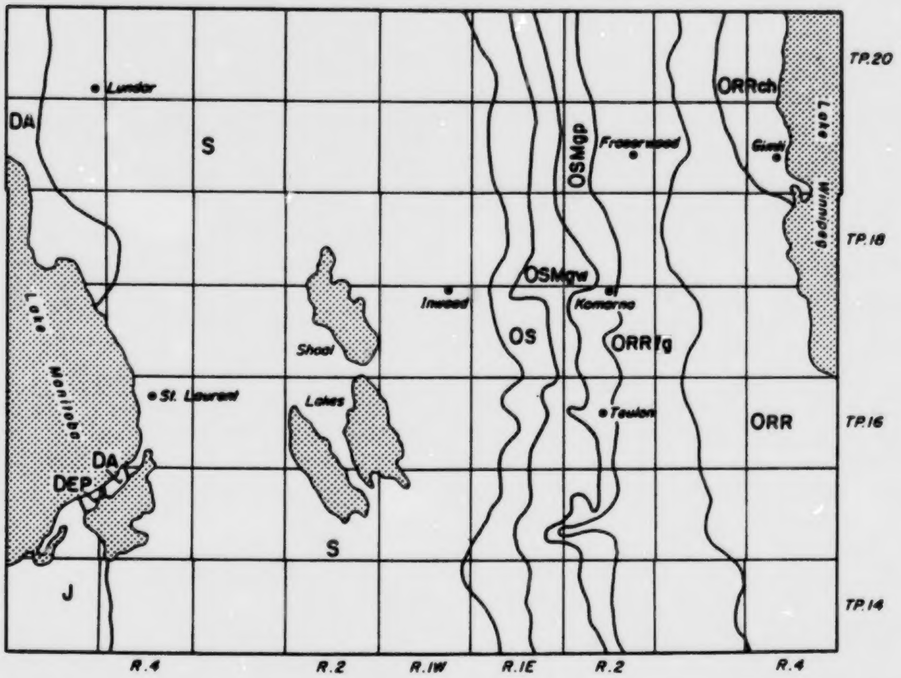
1.4 RELIEF AND DRAINAGE

The principal relief and drainage features of the study areas are shown in Figure(s) 3. The relief ranges from an elevation of 813 ft. (247 m) on the Lake Manitoba Shoreline to about 910 ft. (277 m) at Inwood. At Komarno the elevation is about 862 ft. (262 m) a.s.l. while at Fraserwood it ranges from 825 ft. (251 m) to 850 ft. (259 m) a.s.l. The land surface is level to gently sloping with a distinctive low ridge and swale pattern which has a general northwest to southeast orientation. The ridges rise only slightly above the intervening depressions, however they have a major damming effect on the area drainage.

Surface drainage is not well developed over most of the study area. Problems occur when runoff from the highs collects in the adjoining swales or in swamps and intermittent lakes. Improvement is difficult due to a lack of natural channels and the presence of numerous ridges which interfere with the natural gradient. Presently the drainage of the area is accomodated largely by a system of drains and ditches contributory to the Netley and Osier Creeks. The general direction of flow is to the southeast, eventually emptying into Lake Winnipeg.

1.5 PHYSIOGRAPHY

The distribution of physiographic areas occuring in the study area is shown in Figure 4. The entire area is within the Manitoba Plain Division of the Interior Plains Region of Canada. The Interlake Plain Section encompasses the areas of Komarno, Inwood and Fraserwood. It is a gently undulating area of ground moraine consisting of dominantly limestone and granitic materials. Limestone bedrock may outcrop in some areas or be covered by only a thin mantle of glacial drift. The Lake Manitoba Shoreline portion of the study is situated in the Red River Valley Subsection of the Red River Valley Section. Sandy beach ridges which parallel the Lake Manitoba shoreline predominate in this area, complemented by marsh and open water.


Lundar
DA
S
Fraserwood
OSMgp
ORRch
Gimli
Lake Winnipeg
TP.20
TP.18
Lake Manitoba
Shoal
Lakes
Inwood
OSMgw
Komarno
OS
ORRfg
St. Laurent
Teulon
ORR
TP.16
DA
DEP
S
J
TP.14
R.4
R.2
R.1W
R.1E
R.2
R.4

Jurassic	
J	Amaranth Formation: red argillaceous siltstone and sandstone overlain by gypsum or anhydrite. Reston Formation: limestone and dolomite, shale interbeds. Melita Formation: fine-grained sandstone, variegated shale, minor limestone.
Devonian	
DwDEP	Elm Point Formation: high calcium limestone biomicrite. Winnipegosis Formation: lower member – dolomitized platform facies, upper member – thin inter-reef bituminous laminates, or thick reefal carbonates.
DA	Ashern Formation: dolomitic shale and argillaceous dolomite, red to greenish grey
Silurian	
S	Interlake Group: Fisher Branch (FB), Inwood (I), Moose Lake (ML), Atikameg (A), East Arm (EA), and Cedar Lake (CL) Formations: micritic, fossiliferous, stromatolitic and biostromal dolomites with several sandy/argillaceous marker beds.
Ordovician	
Os	Stonewall Formation: dolomite, fine-grained, sparsely fossiliferous, in part conglomeratic.
Upper Ordovician	
OSM gw gp	Stony Mountain Formation: Gunn and Penitentiary Members (gp) – calcareous shale, fossiliferous limestone and argillaceous dolomite Gunton and William Members (gw) – nodular dolomite, and sandy argillaceous dolomite.
ORR ch fg	Red River Formation: Dog Head Member (dh) – mottled dolomitic limestone. Cat Head Member (ch) – cherty dolomite, Selkirk Member (s) – mottled dolomitic limestone and limestone, Fort Garry Member (fg) – massive to laminated dolomite, minor argillaceous dolomite and high-calcium limestone; in part cherty.

Figure 2: Geology of Study Area

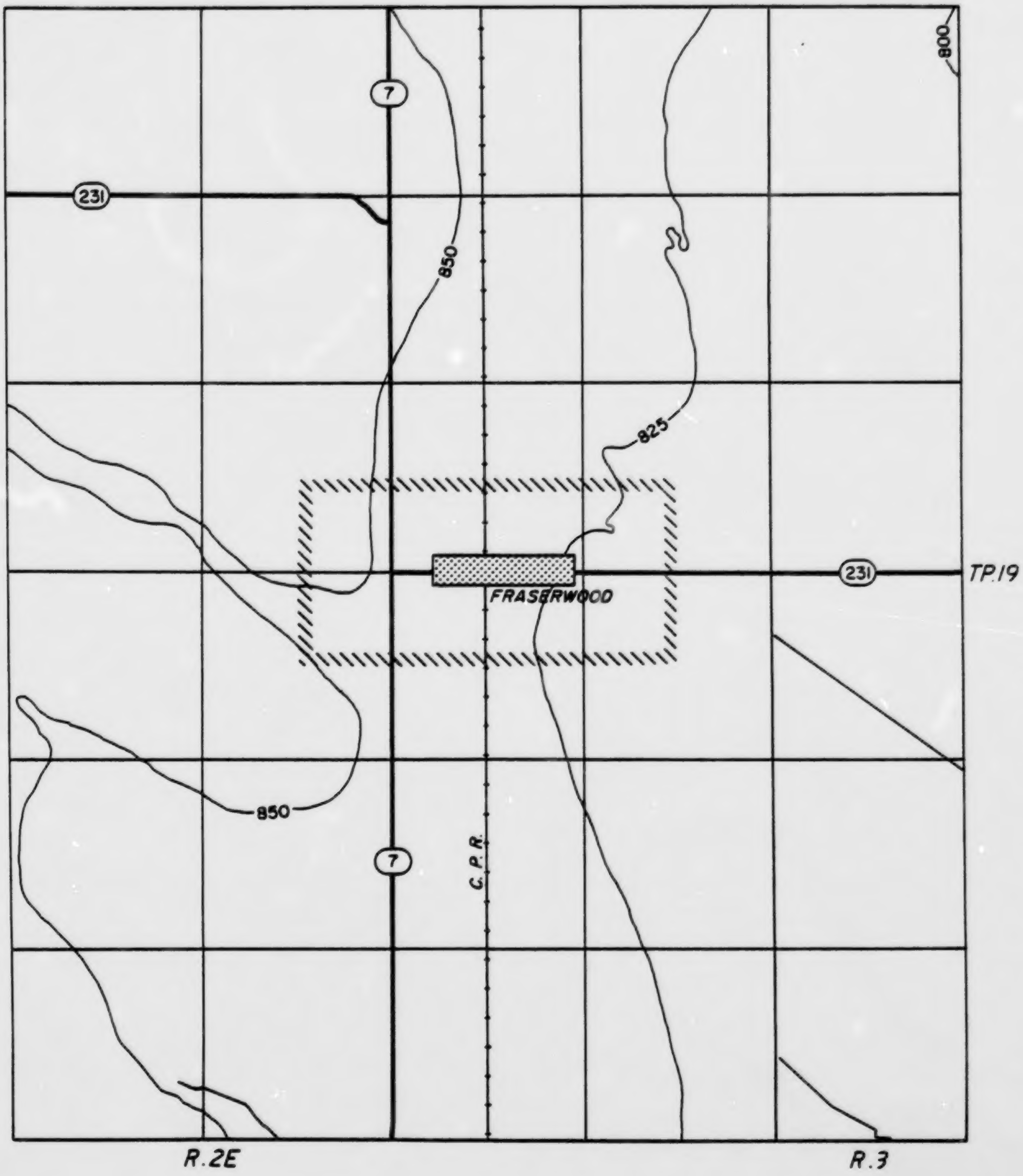

800
7
231
850
825
FRASERWOOD
231
TP.19
850
7
C.P.R.
R.2E
R.3

Figure 3a Relief and Drainage of Fraserwood Area.

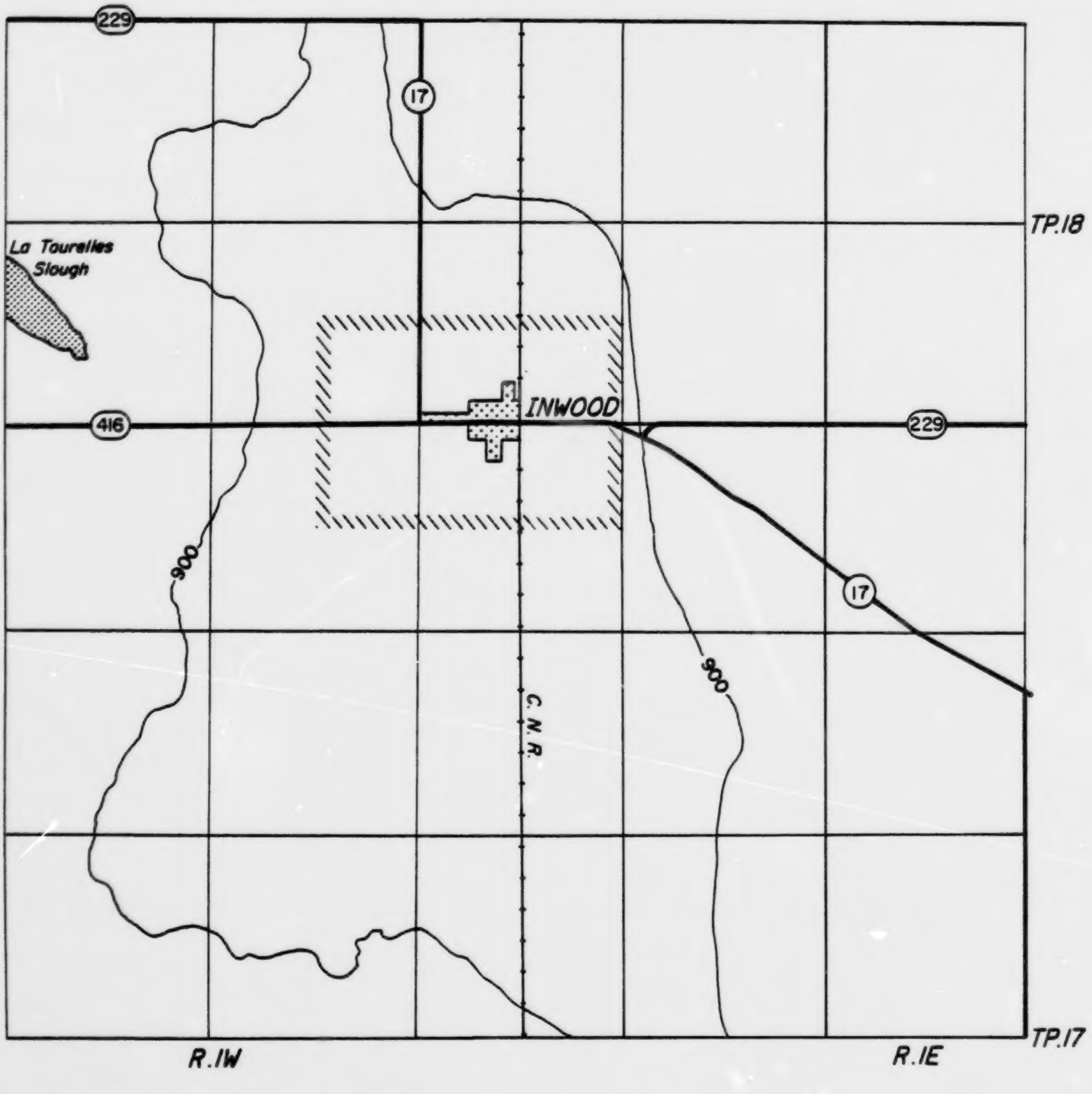

229
17
TP.18
La Tourelles Slough
416
INWOOD
229
900
17
900
C.N.R.
TP.17
R.1W
R.1E

Figure 3b Relief and Drainage of Inwood Area.

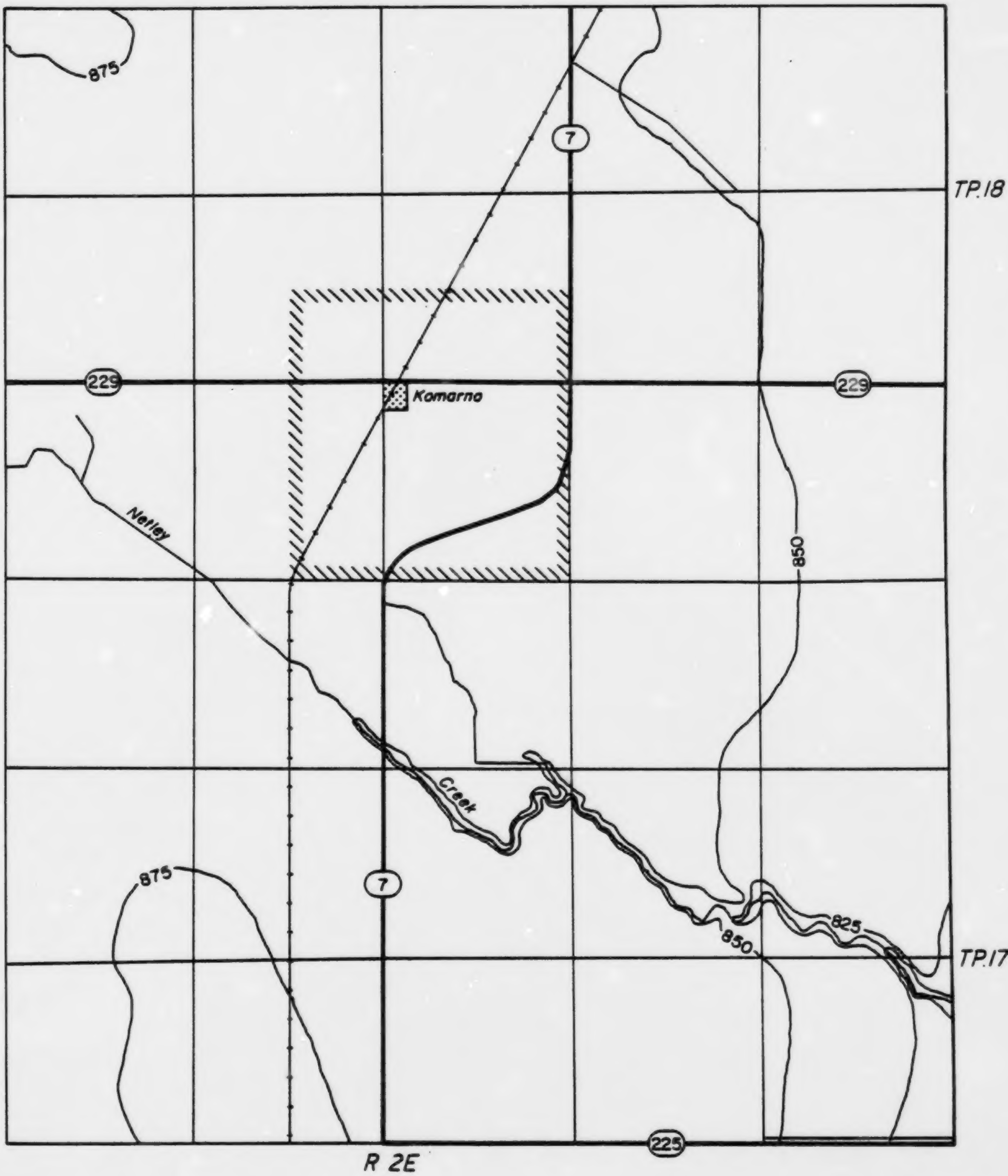

875
7
TP.18
229
Komarno
229
Netley
850
Creek
875
7
825
850
TP.17
225
R 2E

Figure 3c Relief and Drainage of Komarno Area.

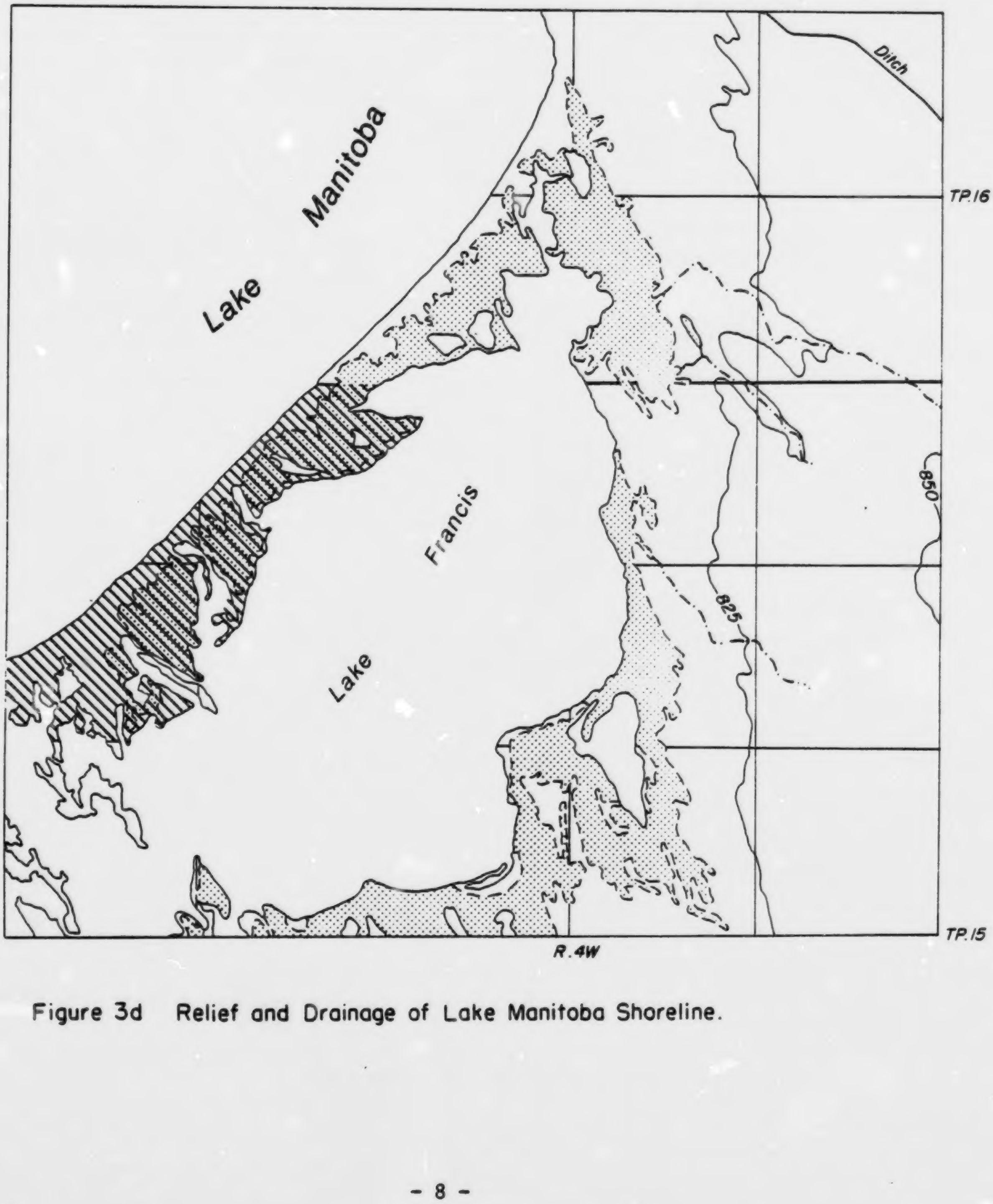
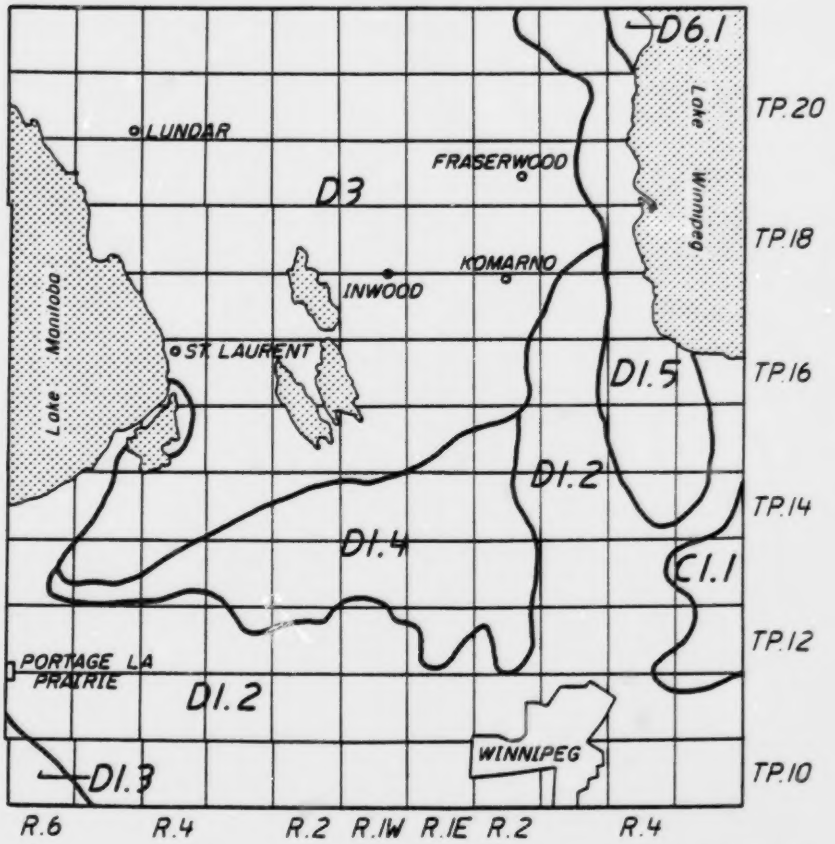

Lake Manitoba
Ditch
TP.16
850
Lake Francis
825
TP.15
R.4W

Figure 3d Relief and Drainage of Lake Manitoba Shoreline.


D6.1
Lake Winnipeg
TP.20
LUNDAR
FRASERWOOD
D3
TP.18
KOMARNO
INWOOD
Lake Manitoba
ST. LAURENT
D1.5
TP.16
D1.2
TP.14
D1.4
C1.1
TP.12
PORTAGE LA PRAIRIE
D1.2
WINNIPEG
TP.10
D1.3
R.6
R.4
R.2
R.1W
R.1E
R.2
R.4

DIVISION	SECTION	SUBSECTION
C Severn Upland	C1 Whitemouth River Plain	.1 Lac du Bonnet Plain
D Manitoba Plain	D1 Red River Plain	.2 Red River Valley
		.3 Lower Assiniboine Delta
		.4 Woodlands Plain
		.5 Lake Winnipeg Terrace
	D3 Interlake Plain	
	D6 Lake Winnipeg Lowland	.1 Icelandic River Lowland

Figure 4 Physiography of Study Area.

1.6 SURFACE DEPOSITS

The study area is primarily characterized by extensive deposits of extremely calcareous, loamy, waterworked, stony till. Evidence of wave action and water-working occurs locally at Komarno and Fraserwood. In these areas, modification appears in the form of thin, discontinuous sand and gravel veneers or ridges in association with the till. Also, a more or less continuous layer or lense of gravelly and cobbly material occurs at the contact of the mantle and underlying till. In some instances the surface appears relatively stone-free as a result of the deposition of thin layers (<1 m) of sands or clays over the till. In addition to the loamy, high lime till, a clay-till consisting of a relatively stone-free, clayey matrix with pockets of high lime till occurs in some locales.

Minor areas of organic soils were mapped north of Komarno. Peaty phases of mineral soils were also delineated in depressional positions of these till landscapes.

The depth to bedrock in the study area is generally within 25 m. However, at the Inwood portion of the study, limestone bedrock is covered by only a thin mantle (<1 m) of glacial drift.

1.7 CLIMATE

In relation to worldwide climatic conditions, the study area is within the region designated as Dfb[1], subhumid cool continental. Due to its location in the center of the continent, summer temperatures are higher and winter temperatures are lower than the world average for the same latitude.

In Manitoba the study area is considered to be within the (HBt_1) High Boreal-Temperate and (MBt_1) Mid Boreal-Temperate climatic regions[2] as shown in Figure 5. Inwood, Komarno and Fraserwood are in the HBt_1 region which is characterized by a mean annual air temperature of 0.2 to 2.2°C and 100 to 120 frost free days. The Lake Manitoba Shoreline portion of the study is more characteristic of the MBt_1 region with an average annual air temperature of 1.0 to 2.8°C and having 100 to 120 frost free days. The mean annual precipitation is approximately 500 mm in both regions.

Data from a more specific site at Fraserwood[3] indicates a mean annual temperature of 1.2°C with July being the warmest and January the coldest months. Total precipitation records show an average annual precipitation of 528 mm with June being the wettest at 82 mm and February being the driest at 17.5 mm. The average length of frost-free period above 0°C is 120 days.

---

[1] Koppen, W. and Geiger, "Handbuck der Klimatologie", Bond L., Teil C., Gebruder Borntraeger, Berlin, 1936.

[2] Mills, G.F., Tarnocai, C. and Shaykewich, C.F. 1977. Characteristics and distribution of soil temperature regimes in Manitoba. Man. Soil Sc. Proc. pp. 56-77. Mills, 1979 Paper.

[3] Canadian Climate Normals, Volumes 2 and 3, Temperature and Precipitation, 1951-1980 Environment Canada, 1982.

1.8 VEGETATION

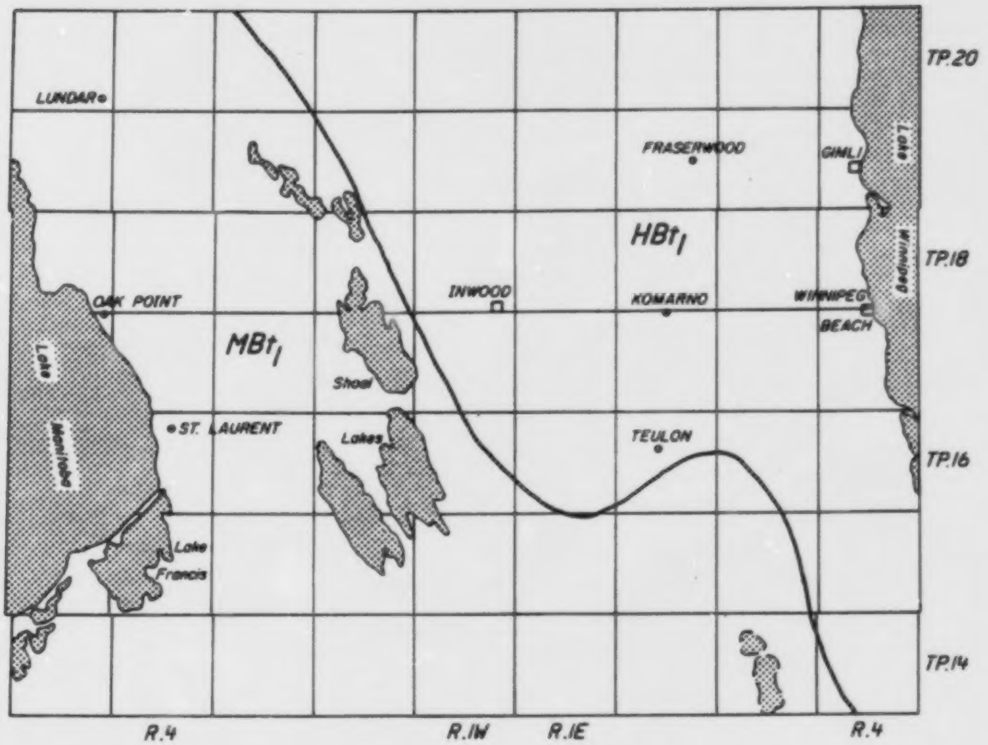
The study area lies within the Boreal Forest Region of Canada as delineated by Rowe[4]. Further separation places the northern part of the study in the Manitoba Lowlands Section and the southern portion in the Aspen-Oak Section.

Aspen is the most prevalent species in the Aspen-Oak Section ranging from small groves invading the grassland to continuous stands. A general distribution of bur oak is characteristic of this section. Wild rye and big and little bluestem are the most common grass species encountered. The native vegetation along the Lake Manitoba Shoreline is dominantly meadow grasses, reeds and sedges.

The Manitoba Lowlands Section to the north is separated from the Aspen-Oak Section on the basis of the distribution limits of the boreal conifers. Aspen is still the dominant species in this region, however black spruce and tamarack are prevalent in the poorly drained areas, and white spruce and jack pine occur on the better drained sites with some oak.

---

[4] Rowe, J.S. 1972. Forest Regions of Canada. Publication No. 1300, Dept. of the Environment, Canada Forestry Service, Ottawa.


TP.20
TP.18
TP.16
TP.14
LUNDAR
FRASERWOOD
GIMLI
Lake Winnipeg
HBt_1
MBt_1
OAK POINT
INWOOD
KOMARNO
WINNIPEG BEACH
Lake Manitoba
Shoal
Lakes
ST. LAURENT
TEULON
Lake Francis
R.4
R.1W
R.1E
R.4

ECOLOGICAL REGION	SUBREGION SYMBOL	TEMPERATURE CLASS	MOISTURE SUBCLASS	DOMINANT SOIL ORDERS	VEGETATION ZONES
High Boreal - Temperate	HBt_1	Cryoboreal, cold to moderately cold	Subhumid to humid	Chernozemic (Dark Gray), Brunisols, Organic	Grassland - Forest Transition
Mid Boreal - Temperate	MBt_1	Cryoboreal, moderately cold to Boreal, cool	Subhumid	Chernozemic (Black), Gleysols	Grassland and Aspen Parkland

Figure 5: Climate of Study Area

PART 2

METHODOLOGY

2.1 MAPPING

Soil mapping in this project was conducted by soil surveyors employing an intensive grid or systematic sampling method. Soil profiles were examined to a depth of one meter at sites approximately 150 meters apart along foot traverses that, in turn, were spaced approximately 0.8 km apart. In this project, the initial inspection point in each section was located 50 to 100 meters from a road allowance fence approximately .4 km from a selected corner of the section to be surveyed. The direction each traverse took was determined on the basis of maximizing the information that could be derived from the range of known soil-landscape variations in each section. Additional sites along road allowances were also examined to help locate soil boundaries between sections. This method of sampling provided approximately 25 to 30 inspection sites per section, or put another way, each site represented approximately 8 to 10 ha. This intensity of sampling permitted the confident delineation of soil mapping units comprised of narrowly defined soil types and other landscape features such as slope, stoniness and erosion on maps at a scale of 1:20 000 (3 inches equal one mile).

2.2 MAP UNITS

A map unit represents mappable portions of the soil landscape that together have characteristics and properties varying within more or less narrow limits that are determined by the intensity of the survey. A map unit contains predominantly one or more than one soil or non-soil individual plus a certain proportion (varying within prescribed limits) of unnamed and undescribed inclusions. They are delineated on the basis of the types and relative proportions of their soils or non-soils, as well as on the basis of external criteria such as slope, stoniness or erosion.

Soil maps show the distribution of kinds of soils and, as such, serves as a link so that the knowledge gained in one locality about the usefulness or behavior of a kind of soil can be extended to other bodies of the same soil.

A map unit is named from its principal component soils or non-soils. It is described in terms of the properties of these components, their relative proportions and other external land attributes. In this project, units are described in terms of named soil series and phases of soil series.

Map units will always contain at least small proportions of inclusions. These inclusions may be soil or non-soil mapping individuals that are named and have their own map units elsewhere in the survey, or they may be rare or insignificant soils or non-soils that are not recognized and named at all in the survey. They may, however, be mentioned in the description of soil types in the report.

2.3 SIMPLE AND COMPOUND MAP UNITS

There are two major types of map units: simple and compound. The difference between them is defined in terms of the proportion and contrast of their components.

A Simple Map Unit contains predominantly one soil or non-soil such as bedrock outcropping. The proportion of its components vary from those that are comprised of at least 65 percent of the predominant type leaving up to 35 percent of similar but non-limiting components to at least 85 percent of the predominant type having up to 15 percent of strongly contrasting, limiting components.

A Compound Map Unit contains predominantly two soils or non-soils (or a combination of the two). The proportion of the two major components may vary from one considerably exceeding the other to both being about equal. If the components are similar and non-limiting, no single component represents more than 65 percent or if they are dissimilar and more limiting, no single component represents more than 75 percent, or if dissimilar and limiting, no single component represents more than 85 percent. Components of mapping units are considered dominant if they occupy over 40 percent of the unit, significant from 15 to 40 percent, and minor if they occupy less than 15 percent. Minor components are described only if they are highly contrasting.

Compound units are employed in mapping complex soil landscapes where dissimilar soils occur in very intricate patterns and in such small segments that it is not practical to delineate them separately on the map.

Very often, it is desirable to indicate by map unit symbol, minor variations in certain intrinsic properties of soils or landscape features that deviate from the normal. These variants or phases of series usually affect soil management. In the study, the effect of four such properties and features are indicated. These are erosion, slope class, degree of stoniness and salinity. The degree or magnitude of each is designated in the following manner:

Erosion

x - none-eroded or minimal
1 - weakly eroded
2 - moderately eroded
3 - severely eroded
O - overblown

Slope Class

x - 0 to 2% level to nearly level
c - 2 to 5% very gently sloping
d - 5 to 9% gently sloping
e - 9 to 15% moderately sloping
f - 15 to 30% strongly sloping
g - 30 to 45% very strongly sloping
h - 45 to 70% extremely sloping

Stoniness

x - non stony
1 - slightly stony
2 - moderately stony
3 - very stony
4 - exceedingly stony
5 - excessively stony

Salinity

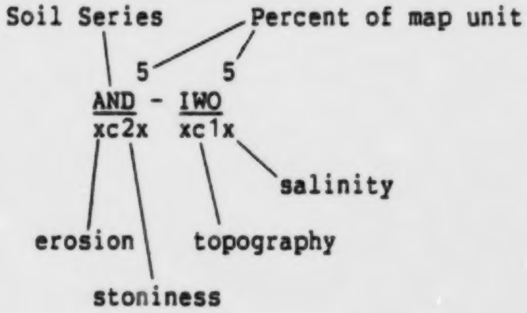
x - non saline (0-4 mS/cm)
s - slightly saline (4-8 mS/cm)
t - moderately saline (8-15 mS/cm)
u - strongly saline (>15 mS/cm)

The convention employed to indicate these features in the map symbol is as follows:

If none of the above properties are observed to be significant, the map symbol representing the normal or unaffected soil series is used alone without modifiers.

If one or more phase features are recognized, the appropriate letter or number is placed below the soil series symbol in one of four designated locations in the map unit symbol. The designated order is erosion, slope class, stoniness and salinity. If a particular feature is not observed to be significant, an x is used in its appropriate designated location in the map symbol.

For example, the compound map unit coded:



Is interpreted to mean that 50 percent of the mapping unit consists of Aneda (AND) series, having minimal or no erosion (x), very gently sloping (c) topography, moderate (2) stoniness, no salinity (x); and 50 percent Inwood (IWO) series having no erosion (x), very gently sloping (c) topography, slightly stony (1) surface conditions and no (x) salinity.

Definitions of the erosion, topography, stoniness and salinity classes are given in the Glossary.

2.4 SAMPLING

During the course of field investigations and mapping, soil samples were taken at selected locations for soil characterization, salinity and irrigation suitability studies. Two profiles were described in detail and sampled for soil characterization analysis (Appendix F). In areas where salinity was suspected to be a problem soils were sampled at 10 to 25 cm and at 50 to 60 cm for electrical conductance measurements and soluble salt analysis.

PART 3

FORMATION, CLASSIFICATION AND MORPHOLOGY OF SOILS

3.1 SOIL DEVELOPMENT

Soil genesis is the process or processes responsible for the development of soil. The principal factors of climate, vegetation, relief and drainage act upon the unconsolidated parent material to produce the soil profile. The type of soil formed in any one place is dependent upon the interaction of these factors and upon the length of time they have been active.

In the study area, the degree of soil development is related to the regional climate and the degree of leaching, translocation and accumulation of the soluble and colloidal fractions of the soil. In grassland areas, the amount of water available for leaching is relatively low, but sufficient to support grassland vegetation; this results in accumulation of organic matter in the mineral surface horizons and gives the soils the "black color". The translocation of soluble and colloidal fraction is relatively shallow. A small portion of the area is mapped as Chernozemic Black soils. In parkland areas (transition from grassland to forest), the soil climate is favorable for tree growth as well as grassland species. There is a greater degree of leaching and translocation than in the grassland area proper, and less organic matter accumulation. The result is the formation of soils with a "dark gray" surface and identifiable accumulation of translocated products such as clay and organic matter lower in the soil profile. A majority of the map area is classified as Chernozemic Dark Gray Soils formed under these conditions. Under more favorable moisture conditions of the forested areas, there is a greater degree of leaching and translocation of soluble and colloidal soil material resulting in soils with a characteristic leaf mat, a bleached light coloured zone and an accumulation zone dominantly of the translocated clay and organic matter. These soils are classified as Luvisols in the map area.

In a similar climatic region, soils may differ due to the texture and mineralogical composition of the parent material. Soils developed on sandy to loamy materials are more permeable to water and allow for a greater leaching of the soluble and colloidal fraction as compared to finer textured soils. Soils developed on moderately calcareous sediments are noticeably deeper than soils developed on strongly calcareous sediments; soils developed on extremely calcareous material are very shallow under grassland (Chernozemic Rego Black), parkland (Chernozemic Dark Gray) or forested conditions (Eutric Brunisol) because of the difficulty of leaching the large quantity of lime carbonate present; the maximum depth of soil development on these extremely calcareous materials is 20 to 30 cm. Most soils of the map area are characterized by shallow profiles resulting from development on extremely calcareous parent materials.

Restrictions on normal soil development are not only imparted by high levels of lime carbonate, but also by the length of the saturation period in an area affected by surface ponding, lateral inflow, seepage or near surface groundwater. Under these conditions, the leaching of soluble and colloidal material is minimal, and in some cases the translocation of soluble soil material is toward the surface; the soil environment is altered from an oxidative state to a depleted oxygen or reductive state. The characteristics associated with various restricted drainage and hydrological conditions are dull soil colors, the development of mottles of iron and managanese, the presence of lime carbonate near the surface of the soils (not applicable to better drained shallow soils developed on extremely calcareous materials), the presence of, and accumulation of soluble salts within the rooting zone, and the accumulation of peat at the surface. The soils in the study area characterized by poor drainage are classified as Gleysols. In addition, soils which are so poorly drained that peat has accumulated to a sufficient depth are classified as Organic Soils e.g. Crane series.

3.2 DESCRIPTION OF SOIL SERIES

Soil series of the study area are described in alphabetical order and include a general description of the genetic profile type, texture, parent material, topography and drainage. General statements on the distribution, surface runoff, stoniness and vegetation characteristics are also given. For additional information and discussion relative to soils of the study area, particularly chemical and physical soil analysis refer to the "Soils of the Matlock-Gimli-Riverton Area" Report No. D23, 1981 and the "Soil Survey of the Fisher and Teulon Map Sheet Areas" Report No. 12, 1961. A convenient, abbreviated key form of table reference on the relationship of soil series in the study to soil drainage, subgroup and parent material is provided in Table 2. A more comprehensive grouping of soils and parent materials is presented in Table 3.

Table 2. Soil Series of the Towns of Fraserwood, Inwood, Komarno and the Lake Manitoba Shoreline Arranged in Relation to Soil Moisture Class, Subgroup and Parent Material.

Soil Moisture Class	Subgroup	PARENT MATERIALS							
		Glacial Till	Till/Limestone Bedrock	Fluvial/Till	Lacustrine over Till			Organic	Miscellaneous Undifferentiated Materials
		Loamy (L,SiL,SiCL)	Loamy (L,SiL,SiCL) over limestone	Sandy skeletal (S & Gr,GrS) over loamy till	Clayey (C,SiC) over loamy till	Loamy (L,SiL, VFSL,SL) over loamy till	Sandy (S,LS) over loamy till	Mesic fen over till	
Well	Orthic Dark Gray	Aneda (AND)	Stonewall (STW)	Gunton (GUO)					Sand Beaches (SDB)
Imperfect	Gleyed Dark Gray	Inwood (IWO)		Beaverdam (BVR)	Peguis (PGU)				
	Gleyed Dark Gray Luvisol						Selina (SLN)		
	Gleyed Gray Luvisol	Piney (PIY)							
	Gleyed Rego Black	Lundar (LUR)		Garrioch (GRH)		Glenhope (GHP)	Pelan (PLN)		
Poor	Rego Humic Gleysol	Meleb (MEB)		Berry Island (BYD	Partridge Creek (PGE)		Sprague (SPG)		Marsh Complex (MHC)
Poor to very poor	Terric Mesisol							Crane (CRN)	

TABLE 3

Parent Materials and Related Soils of the Study Area

A. Glacial Till

1. Soils developed on extremely calcareous, loamy (L, SiL, SiCL) glacial and water modified till.

    a) Well drained

    - Aneda Series (Orthic Dark Gray) AND

    b) Imperfectly drained

    - Inwood Series (Gleyed Dark Gray) IWO
    - Piney Series (Gleyed Gray Luvisol) PIY
    - Lundar Series (Gleyed Rego Black) LUR

    c) Poorly drained

    - Meleb Series (Rego Humic Gleysol) MEB

B. Glacial Till on Limestone Bedrock

1. Soils developed on extremely calcareous, loamy (L, SiL, SiCL) glacial till overlying limestone bedrock within 1 meter.

    a) Well drained

    - Stonewall Series (Orthic Dark Gray, Lithic) SWW

C. Fluvial Deposits on Glacial Till

1. Soils developed on strongly calcareous, stratified, sandy skeletal outwash deposits overlying extremely calcareous, loamy glacial till.

    a) Well drained

    - Gunton Series (Orthic Dark Gray) GUO

    b) Imperfectly drained

    - Beaverdam Series (Gleyed Dark Gray) BVR

    - Garrioch Series (Gleyed Rego Black) GRH

  c) Poorly drained

    - Berry Island Series (Rego Humic Gleysol) BYD

D. Lacustrine Deposits on Glacial Till

1. Soils developed on a thin (<1 m) mantle of moderately calcareous, clayey (C, SiC) lacustrine sediments overlying loamy, extremely calcareous till or a clay-till variant.

  a) Imperfectly drained

    - Peguis Series (Gleyed Dark Gray) PGU

  b) Poorly drained

    - Partridge Creek (Rego Humic Gleysol) PGE

2. Soils developed on thin, strongly calcareous, loamy (L, SiL, VFSL, SL, LVFS) sediments overlying extremely calcareous, loamy glacial till.

  a) Imperfectly drained

    - Glenhope Series (Gleyed Rego Black) GHP

3. Soils developed on thin, moderately to strongly calcareous, sandy (S, LS) lacustrine sediments over extremely calcareous, loamy glacial till.

  a) Imperfectly drained

    - Selina Series (Gleyed Dark Gray Luvisol) SLN

    - Pelan Series (Gleyed Rego Black) PLN

  b) Poorly drained

    - Sprague Series (Rego Humic Gleysol) SPG

E. Organic Deposits

1. Soils developed on 40 to 160 cm of mesic fen peat, underlain by extremely calcareous, loamy glacial till.

  a) Poorly to very poorly drained

    - Crane Series (Terric Mesisol) CRN

F. Miscellaneous Soils and Materials

1. Soils developed on stratified, calcareous, sandy to sandy-skeletal beach and bar deposits of recent origin.

   a) Dominantly well to imperfectly drained

   - Sand Beaches (Orthic Regosol) SDB

   b) Poorly drained

   - Sand Beaches (Rego Gleysol, peaty) SDBp

2. Soils developed on undifferentiated materials, generally lacking profile development and which are saturated for most of the year.

   a) Poor to very poorly drained

   - Marsh (Rego Gleysol) MHC

Aneda Series (AND)

The Aneda series consists of well to moderately well drained Orthic Dark Gray soils developed on extremely calcareous, stony loamy (L, SiL, SiCL) glacial till. The surface texture ranges from a sandy loam to loam. The topography is irregular, very gently to gently sloping. Surface runoff is moderate and permeability is medium to moderately slow. The vegetation consists mainly of aspen with occasional bur oak.

The Aneda soil is characterized by a thin neutral to slightly acid partially decomposed leaf mat, and a dark gray Ahe horizon 3 to 10 cm thick, underlain by a dark yellowish brown Bt horizon of 6 to 12 cm thick. The extremely calcareous C horizon is very pale brown and may have a somewhat platy, fissile structure. The Bt horizon is not as well developed as in the Garson soil. The characteristics of the subsoil of both series are similar.

Beaverdam Series (BVR)

The Beaverdam series consists of imperfectly drained Gleyed Dark Gray soils developed on thin, moderately to strongly calcareous, sandy skeletal outwash deposits overlying extremely calcareous, stony, loamy glacial till. The surface texture ranges from loamy fine sand to loam. A gravelly layer from 10 to 50 cm thick is present above the extremely calcareous till. The topography is level to very gently sloping. The soil drainage is imperfect because of perched water table conditions above the slowly permeable till and lateral flow and seepage of water from adjacent upland areas. The vegetation consists of dominantly trembling aspen, with some dogwood and occasional bur oak.

The soil is characterized by a dark gray Ahe horizon of 10 to 18 cm thick, and a dark grayish brown Bmgj or Btgj within the coarse gravelly layer; the Btgj if present commonly occurs at the contact of the gravelly layer and the till; yellowish brown mottles of iron are present at this contact. The underlying, extremely calcareous loamy till is usually quite compact and often very slowly permeable.

Berry Island Series (BYD)

The Berry Island series consists of poorly drained Rego Humic Gleysol, carbonated phase soils developed on strongly calcareous sandy skeletal outwash or beach deposits overlying extremely calcareous loamy glacial till. The surface textures are variable and range from loamy fine sand to clay loam depending on the amount of inwashing from surrounding areas. The topography is level to depressional; runoff is very slow; permeability is slow. Vegetation consists of sedges, willow, meadow grasses and some black spruce and tamarack.

The Berry Island soil is characterized by a partially decomposed organic layer of 10 to 15 cm thick and is underlain by a carbonated, dark gray Ah horizon 5 to 15 cm thick. A lime enrichment layer may be present below the Ah horizon, depending on the depth at which the gravelly layers are found; the sandy and gravelly deposits are stratified, 50 to 75 cm thick and usually have yellowish brown mottles of iron present. The underlying loamy till deposits are usually light gray and may have fine to medium yellowish brown mottles.

Crane Series (CRN)

The Crane series consists of very poorly drained organic soils developed on shallow deposits of mesic fen peat and underlain by very strongly calcareous loamy till. The Crane series is a Terric Mesisol with a thin fibric surface layer underlain by dominantly mesic fen peat which grades into more decomposed humic fen peat above the mineral substrate. The underlying till substrate occurs between 40 and 160 cm of the surface.

The Crane soils occur in the depressional positions adjacent to the Aneda-Inwood soils and are often associated with Meleb series. The native vegetation is dominantly sedge, reedgrass with some willow and swamp birch. The organic portion of the Crane soils are similar to the Cayer series but differ in the underlying substrate; the Crane series has a loamy, stony extremely calcareous glacial till, whereas the Cayer soils have a stone free lacustrine clay substrate.

Garrioch Series (GRH)

The Garrioch series consists of imperfectly drained Gleyed Rego Black carbonated soils developed on sandy skeletal outwash or beach deposits overlying extremely calcareous loamy glacial till. The surface texture varies from loamy fine sand to sandy clay loam and is underlain by a gravelly layer which varies from 0.5 to one meter thick. The topography is level to very gently sloping. These soils are imperfectly drained due to a perched water table above the slowly permeabile till and to lateral flow and seepage from adjacent upland areas. The native vegetation consists dominantly of tall prairie grasses with some aspen, oak and willow groves.

Glenhope Series (GHP)

The Glenhope series consists of imperfectly drained Gleyed Rego Black carbonated soils developed on strongly calcareous loamy lacustrine sediments overlying extremely calcareous loamy glacial till. The surface texture ranges from loamy very fine sand to fine sandy loam. The topography is level to very gently sloping; runoff is slow. Permeability in the upper strata is moderate when moist, but may be restricted due to a perched water table above the moderately slowly permeable till below, following the spring runoff or heavy summer rains. The native vegetation is meadow-prairie grasses and herbs with scattered groves of aspen, black poplar and willow.

Gunton Series (GUO)

The Gunton series consists of well to moderately well drained Orthic Dark Gray soils developed on thin sandy skeletal outwash deposits overlying extremely calcareous stony, loamy glacial till. The solum is similar to the Leary series with a surface texture ranging from loamy fine sand to fine sandy loam; the thickness of the upper layer is 15 to 40 cm and changes abruptly to stratified gravelly and sandy deposits which vary in thickness from 30 to 60 cm. The topography is irregular, very gently to gently sloping; surface runoff is moderate and permeability is rapid in the upper deposits and moderate to moderately slow in the underlying sediments. Vegetation consists of bur oak, grasses, herbs, hazel and some aspen.

The Gunton series is characterized by a thin partially decomposed leaf mat derived from deciduous and grass vegetation, a dark gray Ah or Ahe horizon of variable thickness depending on the uniformity of the coarse to moderately coarse layer, and a brown to dark yellowish brown Bm or Bt horizon which usually terminates at a layer containing coarse fragments. The underlying loamy glacial till is pale brown and varies in structure from weak fine granular to somewhat platy or fissile.

Inwood Series (IWO)

The Inwood series consists of Gleyed Dark Gray soils developed on extremely calcareous, stony, loamy glacial till. The dominant surface texture is loam. The soils occur on the intermediate and lower landscape positions on very gently to irregular, very gently sloping ridge and swale topography. Runoff is slow and permeability is slow. The groundwater table is usually near the surface during the spring. The Inwood areas are generally moderately to very stony. The native vegetation is dominantly aspen, with some rose, willow, meadow-prairie grasses and herbs.

In water-modified areas where the surface till deposits have been affected by fluvial conditions, the surface texture ranges from gravelly sand to clay loam because of washing, sorting and local deposition. Minor but significant areas of gravelly outwash deposits also occur within the till. These areas are often difficult to separate from the normal till areas because they are very shallow, occur in random pattern and usually have a similar landform. The associated soils developed on these deeper water-modified deposits of sandy and gravelly texture are the well drained Gunton series or imperfectly drained Beaverdam series. Areas of these soils have also been mapped separately.

The Inwood soils exhibit a varying degree of leaching and development. Since these soils have developed under imperfect drainage and may have received waters charged with calcium, the expression of the B horizon varies from a weakly developed Btgj horizon (Dark Gray soil) with some translocated clay and organic matter to transitional or weakly discernible Bgj that may have some carbonates present. Inwood soils are usually characterized by a shallow solum with a thin LH horizon, a thin Ahe horizon 3 to 7.5 cm thick, a weakly developed Bt or Bm horizon 4 to 15 cm thick which grades sharply into light gray, extremely calcareous till.

Inwood clay till variant, which although not mapped in the area occurs in small portions amongst the typical Inwood. This soil has similar solum and properties as the normal Inwood series but differs in the composition and texture of the underlying material or C horizon. The parent material is a till consisting of a heterogenous mixture of moderately to strongly calcareous clayey material and extremely calcareous, loamy till.

Lundar Series (LUR)

The Lundar series consists of imperfectly drained Gleyed Rego Black carbonated soils developed on extremely calcareous loamy and water modified till. In some areas these soils may have a very thin mantle of lacustrine sediments over the till. The surface texture ranges from silty clay loam to loam. The soil occupies the intermediate position between the ridge and swale sequence in the Isafold Association. The topography is level to very gently sloping; runoff is moderately slow, and permeability is moderately slow. The native vegetation consists of native grasses, aspen, black poplar and some willow. These soils usually are very stony.

The Lundar soil is characterized by a thin very dark gray Ah horizon grading directly into the gleyed, extremely calcareous parent material. The A horizon is moderately alkaline and contains considerable lime carbonate.

Marsh Complex (MHC)

The Marsh complex consists of very poorly drained, Rego Gleysol carbonated soils developed on lacustrine clay or thin mucky loam deposits over extremely calcareous till and/or moderately calcareous clay. These soils occur on level to depressional areas that are covered with water and are usually saturated for most of the year. The native vegetation consists entirely of reeds and sedges.

These soils have a thin surface layer of either muck or mineral material high in organic matter content and are underlain by strongly gleyed, olive gray mineral materials. A very thin Ahg horizon, less than 2.5 cm thick, may be present below the muck surface layer.

Marsh soils are undifferentiated with respect to texture and composition of their parent material. They also are much more poorly drained than other Gleysolic soils.

Meleb Series (MEB)

The Meleb series consists or poorly drained, Rego Humic Gleysol carbonated soils developed on extremely calcareous, stony glacial till. A thin peat covering of 10 to 30 cm may be present and underlain by textures ranging from sandy loam to clay, due to some inwash in the level to depressional topographic position. They occur in association with the Aneda and Inwood soils. The native vegetation is dominantly meadow grasses, sedges and herbs with inclusions of willow, black poplar and some aspen.

The Meleb soil profile consists of a thin layer of fen peat overlying a thin dark gray Ah horizon 6 to 10 cm thick, alkaline and calcareous, and underlain by a light gray to white, extremely calcareous till. In soils that have had some inwash or sorting the Ah horizon terminates at the contact of the modified sediments and underlying till. A thin gravelly or cobbly lens may occur at the contact.

Partridge Creek Series (PGE)

The Partridge Creek series consists of poorly drained Rego Humic Gleysol soils developed on thin (15 to 90 cm), moderately to strongly calcareous lacustrine clay overlying stony, water-modified, extremely calcareous till. They occur in the level to depressional sites in the transitional areas between the lacustrine and high lime glacial till soils, usually in association with the Peguis series. Native vegetation is dominantly sedges, with willow, alder and some black spruce.

The Partridge Creek soils have a thin surface layer of very dark brown, slightly acid, moderately decomposed fen peat derived from sedges, hydrophytic herbaceous plants and mosses. This thin organic layer is usually underlain by a thin, neutral to mildly alkaline, very dark gray Ah horizon. The Cg horizon is grayish brown, contains numerous large concretions of lime carbonate, is iron stained, and is moderately alkaline.

Peguis Series (PGU)

The Peguis series consists of imperfectly drained Gleyed Dark Gray soils developed on a moderately to strongly calcareous lacustrine clay underlain by extremely calcareous loamy glacial till within a meter of the surface. The topography is level to very gently sloping; runoff is moderately slow; permeability is moderately slow in the upper clay layer and moderate to moderately slow in the loamy substrate. The native vegetation consists mainly of aspen, white spruce, hazel, and native grasses.

The soil is characterized by a thin, dark brown to black, leaf mat 2 to 4 cm thick, a dark gray, granular A horizon 3 to 10 cm thick, a medium granular dark gray Bgj horizon 12 to 25 cm thick, and a gray Cgj horizon. An increase in pebble and stone content may be noticeable at the contact of the clay and loamy till layer. Small amounts of clay-till may occur in the area.

Piney Series (PIY)

The Piney series consists of imperfectly drained, Gleyed Gray Luvisol soils developed on strongly calcareous glacial till and water-worked till. Surface texture varies from fine sandy loam to clay because of the inclusion of soils with a very thin lacustrine mantle less than 15 cm thick. They occur on low, broad ridges with a smooth, level surface where runoff is slow and internal drainage is moderate to slow. The native vegetation is dominantly aspen with an association of some white spruce and balsam poplar; shrubs such as dogwood, rose, raspberry and brush-honeysuckle; and a ground cover of wild sarsaparilla, northern bedstraw, wild pea, coltsfoot, aster, poison ivy, strawberry, bunchberry, and several species of grass.

In the virgin condition Piney soils are characterized by a thin Aegj horizon overlying a thin, moderately developed textural B horizon that grades abruptly into stony strongly calcareous till. These soils, with a solum generally less than 20 cm thick, when cultivated have a plow layer consisting of a mixture of A and B horizon; and in some sites the layer may include some limy material from the C horizon.

Pelan Series (PLN)

The Pelan series consists of imperfectly drained Gleyed Dark Gray soils developed on thin moderately to strongly calcareous, sandy (S, LS) deltaic or lacustrine deposits overlying extremely calcareous loamy glacial till. The surface texture ranges from loamy fine sand to fine sand. A thin stone line or pebble layer may be present at the contact of the overlay and the high lime till. The topography is level to very gently sloping; permeability is moderate in the surface layers and moderately slow in the subsoil; this results in impeded internal drainage and temporary saturation conditions, following the snowmelt period or above normal precipitation. Runoff is slow. Native vegetation consists of dominantly aspen with some balsam poplar, dogwood or willow.

The Pelan soils are characterized by a thin partially decomposed leaf mat and a dark gray Ah or Ahe horizon 8 to 15 cm thick and a brown to pale brown Bgj horizon of variable thickness from 15 to 40 cm thick that may have slight accumulation or coatings of clay on the sand grains. The solum usually is developed within the overlay, but where the overlay is shallow, part of the B horizon occurs at the contact of the extremely calcareous till. A thin pebble layer or stone line is common at this contact; mottles of iron are common at or above this contact zone.

Sand Beaches (SDB)

Sand beaches are stratified, sandy ridges of recent origin. They are presently in the process of formation in relatively sheltered locations along the Lake Manitoba shoreline. The material varies from relatively pure deposits of fine and medium sand, to gravelly deposits containing many large rounded stones and pebbles. Drainage varies from poor to rapid, dominantly imperfect to rapid, depending upon the topographic position and level of the adjacent lake waters. These areas have little or no profile development, and therefore are considered to be Orthic Regosols. These soil areas have no agricultural or forestry value, but do provide excellent recreational sites. Some sand beaches support scattered stands of willow, aspen, and grasses.

Included in the study area is a poorly drained, peaty phase of Sand Beach which is generally found in the back beach area.

Selina Series (SLN)

The Selina series consists of Gleyed Dark Gray Luvisol soils developed on thin (25 to 100 cm), moderately to strongly calcareous, sandy sediments overlying stony, extremely calcareous till. The texture of the surface horizon can range from fine sand to fine sandy loam, but fine sand is dominant. Scattered surface stones occur on the Selina soils, becoming more numerous where the lacustrine mantle is thin. The Selina soils occupy level to very gently sloping areas, often adjacent to better drained sand and gravel ridges. Runoff is moderate and permeability, although rapid in the upper soil materials, is impeded by the underlying till substrate. The till is moderately permeable and helps to maintain a water table and imperfectly drained soil conditions. Native vegetation is dominantly aspen, balsam poplar and willows with a ground cover of meadow grasses and sedges.

The Selina soils are characterized by a thin, leaf and sod mat underlain by a dark gray Ah horizon and a light gray coloured Ae horizon. The A horizons are in turn underlain by weakly developed brownish gray Btjgj or Bmgj horizons. The lower portion of the B horizon and the light yellowish brown C horizon is gleyed and mottled with iron staining. The Cgj horizon is moderately calcareous and is underlain by extremely calcareous, stony loam till. The contact of the two materials is often marked by a water-worked cobbly and gravelly lens.

Sprague Series (SPG)

The Sprague series consists of Rego Humic Gleysol carbonated soils developed on moderately calcareous sandy lacustrine and outwash deposits overlying extremely calcareous, loamy glacial till within one meter of the surface. The texture of the surface horizon varies from sand to fine sandy loam. Surface drainage is slow; the water table is at or near the surface for the greater part of the growing season. Some scattered surface stones may be present within the map unit. Native vegetation consists of sedge, reeds and willow.

Stonewall Series (STW)

The Stonewall series consists of moderately well to well drained Orthic Dark Gray soils developed on less than one meter (50 to 100 cm) of extremely calcareous, loamy till over limestone bedrock. These soils have a similar solum to the Aneda series but differ in the depth to bedrock. The topography is irregular, gently sloping; runoff is moderate and permeability is moderate in the loamy till and variable in the fractured, permeable limestone bedrock. The native vegetation consists of trembling aspen, bur oak, hazel, forbs and native grasses.

The soil is characterized by a thin, moderately decomposed leaf mat; a thin (4 to 8 cm) dark gray friable A horizon, and a thin (12 to 20 cm) granular, brown B horizon. The solum is normally less than 25 cm thick. The physical characteristics of the solum and parent material are similar to the Aneda series.

PART 4

USE AND MANAGEMENT INTERPRETATIONS OF SOILS

4.1 INTRODUCTION

This section provides predictions of performance or soil suitability ratings for various uses of soils based on field observations of soil and landscape characteristics, laboratory data and on observations of soil behavior under specified conditions of land use and management. Suitability ratings or interpretations are intended only to serve as guides for planners and managers. Caution, with an understanding of the limitations of the soil map must be exercised when applying suitability ratings to soil map units. The value of any rating or interpretation depends upon the nature and composition of individual map unit delineation which in turn depends on the scale of mapping and intensity of ground truthing employed in the survey.

In this section, interpretive soil information is provided for the following land use evaluations:

1. Agriculture
    a) dryland farming capability
    b) irrigation suitability
2. Engineering Uses
3. Recreation Uses

4.2 SOIL CAPABILITY FOR AGRICULTURE

Dryland Agriculture

Soil capability classification for dryland agriculture is based on an evaluation of both internal and external soil characteristics that influence soil suitability and limitations for agricultural use. In this classification, mineral soils are grouped into capability classes, subclasses and units based on their limitations for dryland farming, risk of damage when the soils are used and the way they respond to management[5]. There are seven capability classes, each of which groups soils together that have the same relative degree of limitation or hazard for agricultural use. The limitation becomes progressively greater from Class 1 to Class 7. The class indicates the general suitability of the soils for agriculture. The first three classes are considered capable of sustained production of common field crops, the fourth is marginal for sustained arable culture, the fifth is suitable only for improved permanent pasture, the sixth is capable of use only for native pasture while the seventh class is for soils and land types considered incapable of use for arable agriculture or permanent pasture.

---

[5] Anon. 1965. Land capability classification for agriculture Report No. 2, Canada Land Inventory, Canada Dept. Regional Economic Expansion, Ottawa. 16 pp.

Organic soils within the map area are rated for "potential" agricultural capability after the method of Leeson[6]. Capability ratings of organic soils for agriculture must recognize that most organic soils have little or no value for agriculture in their native state and their potential is only achieved through reclamation or development implemented with varying degrees of difficulty. Capability class definitions for organic soils are the same as for mineral soils. They are however, identified on maps and tables with the prefix "O".

Soil Capability subclasses are divisions within classes which group soils with similar kinds of limitations and hazards for agricultural use. The various kinds of limitations recognized at the subclass level are defined in Table 4.

Soil capability units are divisions within the subclass category that groups soils together that will respond similarly to a given management input.

A summary of the soils in the study area showing their major characteristics and their interpretive classification for dryland agriculture is presented in Table 5.

---

[6] Leeson, Bruce et al. 1969. An organic soil capability classification for agriculture and a study of the organic soils of Simcoe County, Soil Sci. Dept., Ontario Agricultural College, Guelph, Ontario.

Definitions of the Agricultural Capability Classes

Class 1

Soils in this class have no important limitations for crop use. The soils have level or gently sloping topography; they are deep, well to imperfectly drained and have moderate water holding capacity. The soils are naturally well supplied with plant nutrients, easily maintained in good tilth and fertility; soils are moderately high to high in productivity for a wide range of cereal and special crops.

Class 2

Soils in this class have moderate limitations that reduce the choice of crops or require moderate conservation practices. The soils have good water holding capacity and are either naturally well supplied with plant nutrients or are highly responsive to inputs of fertilizer. They are moderate to high in productivity for a fairly wide range of crops. The limitations are not severe and good soil management and cropping practices can be applied without serious difficulty.

Class 3

Soils in this class have moderate limitations that restrict the range of crops or require moderate conservation practices. The limitations in Class 3 are more severe than those in Class 2 and conservation practices are more difficult to apply and maintain. The limitations affect the timing and ease of tillage, planting and harvesting, the choice of crops and maintenance of conservation practices. The limitations include one or more of the following: moderate climatic limitation, erosion, structure or permeability, low fertility, topography, overflow, wetness, low water holding capacity or slowness in release of water to plants, stoniness and depth of soil to consolidated bedrock. Under good management, these soils are fair to moderately high in productivity for a fairly wide range of field crops.

Class 4

Soils in this class have severe limitations that restrict the choice of crops or require special conservation practices or both. These soils have such limitations that they are only suited for a few crops, or the yield for a range of crops may be low, or the risk of crop failure is high. The limitations may seriously affect such farm practices as the timing and ease of tillage, planting and harvesting, and the application and maintenance of conservation practices. These soils are low to medium in productivity for a narrow range of crops but may have higher productivity for a specially adapted crop. The limitations include the adverse effects of one or more of the following: climate, accumulative undesirable soil characteristics, low fertility, deficiencies in the storage capacity or release of soil moisture to plants, structure or permeability, salinity, erosion, topography, overflow, wetness, stoniness, and depth of soil to consolidated bedrock.

Class 5

Soils in this class have very severe limitations that restrict their capability to producing perennial forage crops, and improvement practices are feasible. These soils have such serious soil, climatic or other limitations that they are not capable of use for sustained production of annual field crops. However, they may be improved by the use of farm machinery for the production of native or tame species of perennial forage plants. Feasible improvement practices include clearing of bush, cultivation, seeding, fertilizing and water control.

Some soils in Class 5 can be used for cultivated field crops provided unusually intensive management is used. Some of these soils are also adapted to special crops requiring soil conditions unlike those needed by the common crops.

Class 6

Soils in this class are capable only of producing perennial forage crops and improvement practices are not feasible. Class 6 soils have some natural sustained grazing capacity for farm animals, but have such serious soil, climatic or other limitations as to make impractical the application of improvement practices that can be carried out on Class 5 soils. Soils may be placed in this class because their physical nature prevents the use of farm machinery, or because the soils are not responsive to improvement practices, or because stock watering facilities are inadequate.

Class 7

Soils in this class have no capability for arable culture or permanent pasture because of extremely severe limitations. Bodies of water too small to delineate on the map are included in this class. These soils may or may not have a high capability for forestry, wildlife and recreation.

TABLE 4

Agricultural Capability Subclass Limitations

C - Adverse climate: This subclass denotes a significant adverse climate for crop production as compared to the "median" climate which is defined as one with sufficiently high growing season temperatures to bring field crops to maturity, and with sufficient precipitation to permit crops to be grown each year on the same land without a serious risk of partial or total crop failures.

D - Undesirable soil structure and/or low permeability: This subclass is used for soils difficult to till, or which absorb water very slowly or in which the depth of rooting zone is restricted by conditions other than a high water table or consolidated bedrock.

E - Erosion: Subclass E includes soils where damage from erosion is a limitation to agricultural use. Damage is assessed on the loss of productivity and on the difficulties in farming land with gullies.

F - Low fertility: This subclass is made up of soils having low fertility that either is correctable with careful management in the use of fertilizers and soil amendments or is difficult to correct in a feasible way. The limitation may be due to lack of available plant nutrients, high acidity or alkalinity, low exchange capacity, high levels of carbonates or presence of toxic compounds.

I - Inundation by streams or lakes: This subclass includes soils subjected to inundation causing crop damage or restricting agricultural use.

L - Coarse wood fragments: In the rating of organic soils, woody inclusions in the form of trunks, stumps and branches (>10 cm diameter) in sufficient quantity to significantly hinder tillage, planting and harvesting operations.

M - Moisture limitation: This subclass consists of soils where crops are adversely affected by droughtiness owing to inherent soil characteristics. They are usually soils with low water-holding capacity.

N - Salinity: Designates soils which are adversely affected by the presence of soluble salts.

P - Stoniness: This subclass is made up of soils sufficiently stony to significantly hinder tillage, planting, and harvesting operations. Stony soils are usually less productive than comparable non-stony soils.

R - Consolidated bedrock: This subclass includes soils where the presence of bedrock near the surface restricts their agricultural use. Consolidated bedrock at depths greater than 1 meter from the surface is not considered as a limitation, except on irrigated lands where a greater depth of soil is desirable.

T - Topography: This subclass is made up of soils where topography is a limitation. Both the percent of slope and the pattern or frequency of slopes in different directions are important factors in increasing the cost of farming over that of smooth land, in decreasing the uniformity of growth and maturity of crops, and in increasing the hazard of water erosion.

W - Excess water: Subclass W is made up of soils where excess water other than that brought about by inundation is a limitation to their use for agriculture. Excess water may result from inadequate soil drainage, a high water table, seepage or runoff from surrounding areas.

X - Cumulative minor adverse characteristics: This subclass is made up of soils having a moderate limitation caused by the cumulative effect of two or more adverse characteristics which singly are not serious enough to affect the class rating.

Irrigation Suitability

Irrigation suitability of soils is determined by evaluating the nature of both internal and external soil characteristics[7]. The classification of soils for irrigation suitability consists of three categories: class, subclass and unit.

The suitability class groups soils having the same relative suitability or degree of limitation or hazard for irrigation use. Four classes are utilized grading from Class 1, which is very good to Class 4, which is poor. The four classes are:

Class 1 - Very good: These are soils of fine sandy loam to clay loam texture which are well suited for irrigation use. The soils have good water retention capacity, good permeability, low salt content, good drainage and low general gradient of land surface.

Class 2 - Good: These are soils of loamy fine sand to light clay texture which are moderately well suited for irrigation use. Slight limitation to use results from soil factors such as water holding capacity, permeability, depth of material, salt content, topographic factors such as slope and pattern or drainage restrictions arising from surface drainage and depth to water table.

Class 3 - Fair: These are coarse or fine textured soils which are fair to marginally suitable because of some unfavorable characteristics that limit production and cause management problems under irrigation use. Soil, topographic or drainage factors are more restrictive than in Class 2.

Class 4 - Poor: These are soils that are considered poor to unsuitable for irrigation use because of severe drainage problems, impermeable geologic material, salinity, very low water holding capacity, very rapid permeability, topography or a combination of these problems.

The suitability subclass identifies soils with similar kinds of limitations and hazards related to both internal and external soil characteristics. The internal characteristics include both permanent and non-permanent properties; the permanent properties are those that will not change over time whereas the non-permanent properties may be altered with time by specific management. The properties which affect irrigation suitability of soil are listed as follows:

1. Internal Characteristics
    a) Permanent - Texture, uniformity and depth of geologic deposit, hydraulic conductivity and water storage capacity
    b) Non-permanent - Structure, drainage, fertility, reaction, salinity, exchangeable sodium
2. External Characteristics

---

[7] PFRA. 1964. Handbook for the classification of irrigation land in the prairie provinces. Prepared by Committee of the Canada Dept. of Agriculture. PFRA, Regina, Sask. 92 pp.

a) Topography, erosion, stoniness, vegetative cover

The classification criteria for irrigation suitability are summarized in Table 11, Appendix B. The soils of the Fraserwood, Inwood, Komarno and Lake Manitoba Shoreline areas are evaluated for irrigation suitability in Table 5.

TABLE 5. AGRICULTURE CAPABILITY CLASSES FOR SOILS

Map Symbol and Phase	Soil Name	Agricultural Capability Class	Irrigation Suitability
AND	Aneda	2X	3S
AND /xx2x	Aneda	3P	3S
AND /xx3x	Aneda	4P	3S
AND /xx4x	Aneda	5P	4S
BYD	Berry Island	5W	4D
BYD /xx1x	Berry Island	5W	4D
BVR	Beaverdam	4M	4SD
BVR /xx2x	Beaverdam	4M	4SD
CRN	Crane	O5WD	4D
GHP	Glenhope	2W	3SD
GRH	Garrioch	3M	4S
GUO	Gunton	5M	4S
GUO /xx2x	Gunton	5M	4S
GUO /xx3x	Gunton	5M	4S
IWO	Inwood	2W	4SD
IWO /xx1x	Inwood	2W	4SD
IWO /xx2x	Inwood	3P	4SD
IWO /xx3x	Inwood	4P	4SD
LUR	Lundar	2W	4SD
LUR /xx2x	Lundar	3P	4SD
LUR /xc2x	Lundar	3P	4SD
MEB	Meleb	5W	4D
MEBp	Meleb	5W	4D
MEB /xx1x	Meleb	5W	4D
MEB /xx2x	Meleb	5W	4D
MHC	Marsh Complex	7W	4D
PGE	Partridge Creek	4W	4D
PGU	Peguis	2W	4SD
PGU /xx2x	Peguis	3P	4SD
PIY	Piney	3SW	4SD
PIY /xx2x	Piney	3P	4SD
PLN	Pelan	3M	3SD
PLN /xx1x	Pelan	3M	3SD
SDB	Sand Beaches	7M	4S
SDBp	Sand Beaches	7W	4S
SDB /xcxx	Sand Beaches	7M	4S
SLN	Selina	3M	3SD
SLN /xx1x	Selina	3M	3SD
SLN /xx2x	Selina	3MP	3SD
SPG	Sprague	4W	4D

TABLE 5. AGRICULTURE CAPABILITY CLASSES FOR SOILS

Map Symbol and Phase	Soil Name	Agricultural Capability Class	Irrigation Suitability
SPGp	Sprague	5W	4D
STW	Stonewall	4R	4S
STW /xx3x	Stonewall	4RP	4S
STW /xx4x	Stonewall	5P	4S

4.3 SOIL SUITABILITY FOR SELECTED ENGINEERING USES

This section provides information which can be used by engineers and land use planners concerned with engineering and related geotechnical aspects of soil. It is intended to supplement the information on the soil map with additional data on engineering properties of soils.

The criteria used to evaluate soil suitability for selected engineering and related recreational uses are adopted from guides found in Coen *et al*[8]. and from guidelines developed by the Soil Conservation Service, United States Department of Agriculture[9] and the Canada Soil Survey Committee[10].

Definition of Soil Suitability Classes

Evaluation of soil suitability for engineering and recreation uses is based on both internal and external soil characteristics. Four soil suitability classes are used to evaluate both mineral and organic soils and hence, mapping units for selected uses. These ratings express relative degrees of suitability or limitation for potential uses of natural or essentially undisturbed soils. The long term effects of the potential use on the behavior of the soil are considered in the rating.

The four suitability class ratings are defined as follows:

Good -	Soils in their present state have few or minor limitations that would affect the proposed use. The limitations would easily be overcome with minimal cost.
Fair -	Soils in their present state have one or more moderate limitations that would affect the proposed use. These moderate limitations would be overcome with special construction, design, planning or maintenance.
Poor -	Soils in their present state have one or more severe limitations that would severely affect the proposed use. To overcome these severe limitations would require the removal of the limitation or difficult and costly alteration of the soil or of special design or intensive maintenance.
Very Poor -	Soils have one or more features so unfavorable for the proposed use that the limitation is very difficult and expensive to overcome or the soil would require such extreme alteration that the proposed use is economically impractical.

---

[8] Coen et al. 1977. Soil Survey of Yoho National Park, Canada. Alberta Soil Survey Report No. 37. 208 pp. Alberta Institute of Pedology, University of Alberta, Edmonton, Alberta.

[9] USDA. 1971. Guide for Interpreting Engineering Uses of Soils. Soil Conservation Service, USDA. SCS-45. 87 pp.

[10] CSSC. 1973. Proceedings of the Ninth Meeting of the Canada Soil Survey Committee, University of Saskatchewan, Saskatoon. 357 pp.

Soil Suitability Subclasses

The basic soil properties that singly or in combination with others commonly affect soil suitability for selected engineering properties and recreation uses are provided in Table 6. These subclass designations serve to identify the kind of limitation or hazard for a particular use.

Guides for Assessing Soil Suitability

Guides for assessing soil suitability for ten engineering related uses are given in Appendix B, Tables 12 to 21. These tables provide as specifically as possible, definitions of the soil properties which result in the specific suitability or degree of limitation. In assessing soil suitability for various engineering uses, the degree of suitability is determined by the most restrictive or severe rating assigned to any one of the listed soil properties. For example, if the suitability is "Good" for all but one soil property and it is estimated to be "Very Poor", then the overall rating of the soil for that selected use is "Very Poor". Suitability of individual soil properties, if estimated to be "Fair" or "Poor", can be accumulative in their effect for a particular use. Judgement is required to determine whether the severity of the combined effects of several soil properties on suitability for a particular use will result in downgrading an evaluation. This is left to the discretion of the interpreter. It is incorrect to assume that each of the major soil properties influencing a particular use has an equal effect. Class limits established for rating the suitability of individual soil properties take this into account. For a selected use, therefore, only those soil properties which most severely limit that use are specified.

Engineering description of the soils and their estimated properties significant to engineering are provided in Table 7. These data, in addition to information contained in other sections of the report have been used to rate the soils according to their suitability for ten selected engineering uses in Table 8. When using these interpretations, consideration must be given to the following assumptions:

1. Interpretations are based on predictions of soil behavior under defined conditions of use and management as specified in the preamble to each of Tables 12 through 25 (Appendix B).

2. Soil ratings do not include site factors such as nearness to towns and highways, water supply, aesthetic values, etc.

3. Soil ratings are based on natural, undisturbed soil.

4. Soil suitability ratings are usually given for the entire soil, but for some uses, they may be based on the limitations of an individual soil horizon or other earthy layer, because of its overriding importance. Ratings rarely apply to soil depths greater than 1 to 2 meters, but in some kinds of soils, reasonable estimates can be given for soil material at greater depths. It should be noted here that the term "soil" has been used throughout the report in the pedologic sense and differs in concept from that commonly used by engineers.

5. Poor and very poor soil ratings do not imply that a site cannot be changed to remove, correct or modify the soil limitations. The use of soils rated as poor depends on the nature of the lim-

itations, whether or not the soil limitation can be altered successfully and economically, and on the scarcity of good sites.

6. Interpretations of map units do not eliminate the need for on-site evaluation by qualified professionals. Due to the variable nature of soils, and the scale of mapping, small, unmappable inclusions of soils with different properties may be present in an area where a development is planned. The need for or importance of on-site studies depends on the use to be made of the soil and the kinds of soil and soil problems involved.

4.4 SOIL SUITABILITY FOR SELECTED RECREATION USES

This section provides interpretations of the soil suitability for recreational development. All types of soil can be used for recreational activities of some kind.

Soils and their properties determine to a large degree, the type and location of recreational facilities. Wet soils are not suitable for campsites, roads, playgrounds or picnic areas. Soils that pond and dry out slowly after heavy rains present problems where intensive use is contemplated. It is difficult to maintain grass cover for playing fields and golf courses on droughty soils. The feasibility of many kinds of outdoor activities are determined by other basic soil properties such as depth to bedrock, stoniness, topography or land pattern, and the ability of the soil to support vegetation of different kinds as related to its natural fertility.

The suitability of the various soil series and phases for selected recreation uses is shown in Table 9 according to four classes, Good, Fair, Poor and Very poor defined previously in the section on Engineering Uses. Subclasses are employed to identify the kind of limitation or hazard for a particular use. An explanation of subclass symbols are provided in Table 6.

The guidelines for various recreation uses are presented in Appendix B, Tables 22 to 25 and 15.

TABLE 6

Codes utilized to identify limitations in evaluating soil suitability for selected Engineering and Recreational Uses(Tables 8 and 9)

a	subgrade properties
b	thickness of topsoil
c	coarse fragments on surface
d	depth to bedrock
e	erosion or erodibility
f	susceptibility to frost hazard
g	contamination hazard of groundwater
h	depth to seasonal water table
i	flooding or inundation
j	thickness of slowly permeable material
k	permeability or hydraulic conductivity
l	shrink-swell properties
m	moisture limitations or deficit
n	salinity or sulphate hazard
o	organic matter
p	stoniness
q	depth to sand or gravel
r	rockiness
s	surface texture
t	topographic slope class
u	moist consistence
w	wetness or soil drainage class
z	permafrost

Table 7. Engineering Description of the Soils and Their Estimated Properties Significant to Engineering

Map Symbol	Soil Series	Depth (cm)	Classification			% Passing			Perme-ability* (cm/hr)	Reaction	Sulfate** Hazard	Dispersion	Shrink-Swell	Depth to Watertable
			USDA	Unified	AASHO	No. 10 (2.0mm)	No. 40 (0.42mm)	No. 200 (.074mm)						
AND	Aneda	0-25	L-CL	CL to ML	A-4	70-90	65-80	45-65	1.5-5.0	6.5-7.0	none	low	moderate	1.5 m
		25-75	L-SiL	CL to ML	A-4	70-85	60-80	40-60	1.5-5.0	7.8-8.2	low	low	moderate	
BYD	Berry Island	0-25	SL-L	SM	A-2-4 or A-4	90-100	65-90	30-65	6.0-12.0	7.6-8.0	low	low	low	seasonal
		25-60	GrLS	Gp to Gw	A1	40-70	15-30	2-5	> 25.0	7.8-8.0	low	low	low	at surface
		60+	L-SiL	CL to ML	A-4 or A-6	70-85	60-80	40-60	.1-.5	7.8-8.2	low	low	moderate	
BVR	Beaverdam	0-25	FSL	SM to ML	A-4	80-90	70-85	20-30	12.0-25.0	6.6-7.2	none	low	low	seasonal
		25-60	Gr-LS	GP to GW	A-1	50-80	15-30	5-10	> 25	7.8-8.0	none	low	nil	at .5 m
		60+	L-SiL	CL to ML	A-4	70-85	60-80	40-60	.25-1.3	7.8-8.2	low	low	moderate	
CRN	Crane	0-100	Mesic peat	-	-	-	-	-	-	6.0-7.0	low	low	-	at surface
		100+	L-SiL	CL to ML	A-4 to A-6	70-85	60-80	40-60	.25-1.5	7.8-8.2	low	low	moderate	
GHP	Glenhope	0-40	L-VFSL	ML	A-4 to A-6	100	95-100	85-95	2.-6.0	7.4-7.8	low	low	moderate	seasonal
		40-90	LVFS-SiL	ML	A-4 to A-6	100	95-100	85-95	5.-12.0	7.6-8.0	moderate	low	moderate	.5 m
		90+	SiL-SiCL	ML to CL	A-4 to A-6	75-90	70-85	50-75	2.5	7.6-8.0	moderate	low	moderate	
GRH	Garrioch	0-25	FSL-LFS	SP to SM	A-2-4	80-95	70-85	20-40	12.-25.	7.2-7.4	none	mod. low	low	seasonal
		25-60	Gr S	Gp to GW	A-1	35-70	15-30	1-5	25	7.8-8.0	none	none	none	within .5 m
		60+	L-SiL	CL to ML	A-4 to A-6	70-85	60-80	40-60	.25-1.2	7.8-8.2	low	low	moderate	
GUO	Gunton	0-25	LFS-FSL	SM	A-2-4 to A-4	80-90	70-85	20-30	12.7-25.4	6.6-7.2	none	low	low	greater
		25-75	Gr-LS	Gp to GW	A-1	50-80	15-30	1-5	> 25	7.6-8.0	none	low	none	than 2 m
		75+	L-SiL	CL to ML	A-4 to A-6	70-85	60-80	40-60	.1-.5	7.8-8.2	low	low	moderate	
IWO	Inwood	0-20	L-CL	CL to CH	A-6 to A-7-5	75-90	65-80	50-70	1.5-5.1	7.0-7.2	none	low	moderate	seasonal
		20-100	L-SiL	CL	A-4	70-85	60-80	45-65	1.5	7.6-8.0	low	low	moderate	0.5 m
LUR	Lundar	0-25	L-CL	CL	A-6 to A-7-6	85-95	75-90	50-80	1.5-5.1	7.4-7.8	low	low	moderate	seasonal
		25-100	L-SiCL	ML to CL	A-4 to A-6	85-95	75-90	50-75	1.5	7.8-8.2	moderate	low	moderate	.5 m

Table 7. Cont'd

Map Symbol	Soil Series	Depth (cm)	Classification			% Passing			Perme-ability* (cm/hr)	Reaction	Sulfate** Hazard	Dispersion	Shrink-Swell	Depth to Watertable
			USDA	Unified	AASHO	No. 10 (2.0mm)	No. 40 0.42mm)	No. 200 (.074mm)						
MEB	Meleb	0-15	L-CL	OL to OH	A-4 to A-6	80-95	70-80	50-70	1.5-5.1	7.6-8.0	low	low	moderate	seasonal
		15+	L-SiCL	ML to CL	A-4 to A-6	80-95	70-80	50-70	.5	7.8-8.2	moderate	low	moderate	at surface
MHC	Marsh	0-25	Muck and SiL	OL	A-4	100	100	80-100	2.5-5.0	7.5-8.0	none to moderate	low	moderate	at surface
		25-50	SiL	ML	A-4	100	100	80-100	2.5-5.0	7.5-8.0	none to moderate	low	moderate	
		50+	L Till	ML-CL	A-4 to A-6	90-100	70-90	50-70	1.0-5.0	8.0-8.5	none to moderate	low to moderate		
PGE	Partridge Creek	0-25	C	OH	A-7-6	90-100	85-95	85-95	<.15	6.5-7.4	low	low	high	seasonal
		25-50	C	CH	A-7-6	90-100	85-95	85-95	<.15	7.4-8.2	low	low	high	at or near
		50+	SiL-SiCL	Ml to CL	A-4 or A-6	75-90	50-85	50-70	.13-.5	7.6-8.2	moderate	low	moderate	surface
PGU	Peguis	0-40	C	CH	A-7-6	100	100	90-100	.1-.5	6.6-7.0	low	low	high	seasonal
		40-60	C	CH	A-7-6	100	100	90-100	.1-.5	7.0-7.4	low	low	high	at 1.2 m
		60-100	Sil-SiCL	ML to CL	A-4 or A-6	80-95	70-80	60-80	< 1.5	7.6-8.2	low	low	moderate	
PIY	Piney	0-20	L-CL	CL to CH	A-6 to A-7	75-90	65-80	50-70	1.5-5.1	7.0-7.2	none	low	moderate	seasonal
		20-100	L-SiL	CL	A-4	70-80	60-80	45-65	1.5	7.6-8.0	low	low	moderate	0.7 m
PLN	Pelan	0-30	LFS	SM		90-100	80-95	10-25	6-12	6.8-7.2	low	low	low	
		30-75	FS	SM to SP	A-2-4	90-100	80-95	3-15	6-12	7.2-7.6	low	low	low	
		75+	SiL-SiCL	ML to CL	A-4 to A-6	75-70	70-85	50-75	2.0	7.6-8.2	low	low	moderate	seasonal to .8 m
SDB	Sand Beaches	0-100	Stratified FS-MS,Gr	SP,GP,GM or SM	A-1 to A-2	50-100	15-50	0-15	25.0	7.0-8.0	none	low	low	varies with lake level

Table 7. Cont'd

Map Symbol	Soil Series	Depth (cm)	Classification			% Passing			Perme-ability* (cm/hr)	Reaction	Sulfate** Hazard	Dispersion	Shrink-Swell	Depth to Watertable
			USDA	Unified	AASHO	No. 10 (2.0mm)	No. 40 (0.42mm)	No. 200 (.074mm)						
SLN	Selina	0-20	LFS	SM	A-2 to A-4	100	85-95	5-35	10.0-20.0	6.0-7.0	none	low	low	seasonal to 0.7 m
		20-80	FS	SM to SP	A-2-4	100	85-95	5-35	10.0-20.0	6.5-7.5	none	low	low	
		80+	L-CL	ML to CL	A-6	75-90	60-80	50-70	.13	7.0-8.0	low	low	moderate	
SPG	Sprague	0-25	LFS-FSL	SM to SP	A-2 to A-4	95-100	85-95	5-25	6-12	7.4-7.8	low	low	low	seasonal at or near surface
		25-75	FS	SM to SP	A-2-4	90-100	80-95	3-15	6-12	7.4-7.8	low	low	low	
		75+	SiL-SiCL											
STW	Stonewall	0-25	SCL-CL	CL	A-6 to A-7	85-95	80-90	45-80	1.3-5.1	6.5-7.0	low	low	moderate	2 m
		25-90	SiL-SiCL	ML to CL	A-4 to A-6	80-95	70-80	35-70	2.5	7.6-8.2	low	low	moderate	
		90+	Limestone Bedrock											

*Permeability of horizons or layers is expressed in cm/hr

very rapid	>25 cm/hr	moderate	2.5-5.0 cm/hr
rapid	15-25 cm/hr	moderately slow	1.5-2.5 cm/hr
moderately rapid	5-15 cm/hr	slow	.125-1.5 cm/hr
		very slow	<.125

**Sulfate Hazard - relative degree of sulfate attack based on criteria extablished by U.S. Bureau of Reclamation.

Table 8. Suitability Ratings of Soils for Selected Engineering Uses. Suitability is designated as G-Good, F-Fair, P-Poor and V-Very Poor. The nature of the most severe limitations is indicated by subclass symbols defined in Table 6 and applied according to use and management conditions specified in the appropriate guide table (Tables 12 to 21, Appendix B). The dominant limitation is indicated first after the rating. Note: The following ratings and interpretations do not eliminate the need for on-site evaluations by qualified professionals.

Map Symbol and Phase	Soil Name	Top Soil (12)	Sand & Gravel (13)	Road Fill (14)	Permanent Bldgs. With Basements (15)	Local Roads and Streets (16)	Sanitary Trench (17)	Landfill Area (18)	Cover Material (19)	Sewage Lagoons (20)	Septic Fields (21)
AND	Aneda	Pb	Va	Fa	Fa	Fa	Fs	G	Fs	Fka	Fk
AND /xx2x	Aneda	Pbp	Va	Fa	Fap	Fa	Fp	G	Fsp	Fka	Fk
AND /xx3x	Aneda	Pbp	Va	Fap	Pp	Fap	Pp	G	Pp	Fka	Fk
AND /xx4x	Aneda	Pbp	Va	Pp	Pp	Pp	Pp	G	Pp	Pp	Fkp
BYD	Berry Island	Pw	Ph	Pw	Vh	Pw	Vw	Pw	Vsw	Vkh	Vh
BYD /xx1x	Berry Island	Pw	Ph	Pw	Vh	Pw	Vw	Pw	Vsw	Vkh	Vh
BVR	Beaverdam	Ps	Pa	Fw	Pw	Fw	Ph	Pk	Vs	Pka	Ph
BVR /xx2x	Beaverdam	Psp	Pa	Fw	Pw	Fw	Ph	Pk	Vs	Pka	Ph
CRN	Crane	Vw[1]	Vah	Vaw	Vah	Va	Vsw	Vw	Vsw	Vah	Vh
GHP	Glenhope	Fb	Va	Fwp	Pw	Fw	Pw	Fw	Fs	Fa	Ph
GRH	Garrioch	Ps	Pa	Fw	Pw	Fw	Ph	Vk	Vs	Pk	Ph
GUO	Gunton	Ps	Fa	G	Fa	G	Fs	Pk	Vs	Pka	Fkg
GUO /xx2x	Gunton	Ps	Fa	G	Fa	G	Fp	Pk	Vs	Pka	Fkg
GUO /xx3x	Gunton	Psp	Fa	Fp	Pp	Fp	Pp	Pk	Vs	Pka	Fkg
IWO	Inwood	Pb	Va	Faw	Paw	Fwa	Pw	Fw	Fs	Fka	Phk
IWO /xx1x	Inwood	Pb	Va	Faw	Paw	Fwa	Pw	Fw	Fs	Fka	Phk
IWO /xx2x	Inwood	Pb	Va	Faw	Paw	Fwa	Pw	Fw	Fsp	Fka	Phk
IWO /xx3x	Inwood	Pbp	Va	Fap	Pwp	Fwp	Pwp	Fw	Pp	Fap	Phk
LUR	Lundar	Pb	Va	Faw	Pw	Faw	Pw	Fw	Fs	Fka	Phk
LUR /xx2x	Lundar	Pb	Va	Faw	Pw	Fwa	Pw	Fw	Fsp	Fka	Phk
LUR /xc2x	Lundar	Pb	Va	Faw	Pw	Fwa	Pw	Fw	Fsp	Fka	Phk
MEB	Meleb	Pw	Va	Pw	Pw	Pw	Vw	Pw	Pw	Ph	Vh
MEBp	Meleb	Vw	Va	Vw	Vha	Va	Vw	Vw	Vsw	Va	Vh
MEB /xx1x	Meleb	Pw	Va	Pw	Pw	Pw	Vw	Pw	Pw	Ph	Vh
MEB /xx2x	Meleb	Pw	Va	Pw	Pw	Pw	Vw	Pw	Pw	Ph	Vh
MHC	Marsh Complex	Vw	Va	Vw	Vwa	Vwa	Vw	Vw	Vw	Vi	Vi
PGE	Partridge Creek	Pws	Va	Pw	Vh	Pw	Vh	Pw	Pws	Fa	Vh
PGU	Peguis	Ps	Va	Pa	Pw	Pa	Pw	Fw	Ps	Fka	Phk
PGU /xx2x	Peguis	Ps	Va	Pa	Pw	Pa	Pw	Fw	Ps	Fka	Phk
PIY	Piney	Pb	Va	Faw	Pw	Fwa	Pw	Fw	Fs	Fka	Phk

TABLE 8. SUITABILITY RATINGS OF SOILS FOR SELECTED ENGINEERING USES

Map Symbol and Phase	Soil Name	Top Soil (12)	Sand & Gravel (13)	Road Fill (14)	Permanent Bldgs. With Basements (15)	Local Roads and Streets (16)	Sanitary Trench (17)	Landfill Area (18)	Cover Material (19)	Sewage Lagoons (20)	Septic Fields (21)
PIY /xx2x	Piney	Pb	Va	Faw	Pw	Fwa	Pw	Fw	Fsp	Fka	Phk
PLN	Pelan	Ps	Pa	Faw	Pw	Fw	Pw	Pk	Fs	Pka	Ph
PLN /xx1x	Pelan	Ps	Pa	Faw	Pw	Fw	Pw	Pk	Fs	Pka	Ph
SDB	Sand Beaches	Ps	Fa	Fw	Viw	Pi	Vks	Vkg	Vs	Vi	Vig
SDBp	Sand Beaches	Ps	Va	Va	Vai	Vi	Vks	Vkg	Vs	Vka	Vig
SDB /xcxx	Sand Beaches	Ps	Fa	Fw	Viw	Pi	Vks	Vkg	Vs	Vka	Vig
SLN	Selina	Ps	Pa	Fw	Pw	Fw	Pw	Pk	Fs	Pka	Ph
SLN /xx1x	Selina	Ps	Pa	Fw	Pw	Fw	Pw	Pk	Fs	Pka	Ph
SLN /xx2x	Selina	Ps	Pa	Fw	Pw	Fw	Pw	Pk	Fsp	Pka	Ph
SPG	Sprague	Ps	Va	Pw	Pw	Pw	Vw	Pw	Pw	Pk	Vh
SPGp	Sprague	Ps	Va	Va	Vwa	Vw	Vw	Vw	Vsw	Va	Vh
STW	Stonewall	Pb	Va	Fd	Pd	Fd	Vd	Pg	Pd	Pd	Pd
STW /xx3x	Stonewall	Pp	Va	Fp	Pdp	Fdp	Vd	Pg	Pdp	Pd	Pd
STW /xx4x	Stonewall	Pp	Va	Pp	Pdp	Pp	Vd	Pg	Pdp	Pdp	Pd

[1] If accessible, the peat may be rated good when mixed with mineral soils.

Table 9. Suitability Ratings of Soils for Recreational Uses. Suitability is designated as G-Good, F-Fair, P-Poor and V-Very Poor. The nature of the most severe limitations is indicated by subclass symbols defined in Table 6 and applied according to use and management conditions specified in the appropriate guide table (Tables 15 and 22-25, Appendix B). The dominant limitation is indicated first after the rating. Note: The following ratings and interpretations do not eliminate the need for on-site evaluations by qualified professionals.

Map Symbol and Phase	Soil Name	Play Ground (22)	Picnic Area (23)	Camp Area (24)	Path And Trails (25)	Permanent Bldgs. Without Basements (15)
AND	Aneda	Fs	Fs	Fs	Fs	Fa
AND /xx2x	Aneda	Fsp	Fs	Fsp	Fs	Fa
AND /xx3x	Aneda	Pp	Fsp	Pp	Fsp	Fap
AND /xx4x	Aneda	Pp	Pp	Pp	Pp	Pp
BYD	Berry Island	Pw	Pw	Pw	Pw	Pw
BYD /xx1x	Berry Island	Pw	Pw	Pw	Pw	Pw
BVR	Beaverdam	Pq	Fw	Fw	Fw	Fw
BVR /xx2x	Beaverdam	Pq	Fwp	Fw	Fw	Fwp
CRN	Crane	Vws	Vsw	Vws	Vws	Vwa
GHP	Glenhope	Fw	Fw	Fw	Fw	Fw
GRH	Garrioch	Fw	Fw	Fw	Fws	Fw
GUO	Gunton	Pq	G	Fm	G	G
GUO /xx2x	Gunton	Pq	Fp	Fm	G	Fp
GUO /xx3x	Gunton	Pqp	Pp	Fmp	Fp	Fp
IWO	Inwood	Fsw	Fws	Fws	Fws	Faw
IWO /xx1x	Inwood	Fsw	Fws	Fws	Fws	Faw
IWO /xx2x	Inwood	Fsw	Fws	Fws	Fws	Faw
IWO /xx3x	Inwood	Pp	Fpw	Pp	Fwp	Fwp
LUR	Lundar	Fsw	Fsw	Fsw	Fsw	Faw
LUR /xx2x	Lundar	Fsw	Fws	Fws	Fws	Faw
LUR /xc2x	Lundar	Fst	Fws	Fwp	Fws	Faw
MEB	Meleb	Pw	Pw	Pw	Pw	Pw
MEBp	Meleb	Vws	Vws	Vws	Vws	Va
MEB /xx1x	Meleb	Pw	Pw	Pw	Pw	Pw
MEB /xx2x	Meleb	Pw	Pw	Pw	Pw	Pw
MHC	Marsh Complex	Vw	Vw	Vw	Vw	Vw
PGE	Partridge Creek	Pws	Pws	Pws	Pws	Pwa
PGU	Peguis	Psw	Pws	Pws	Ps	Pa
PGU /xx2x	Peguis	Psw	Pws	Pws	Ps	Pa
PIY	Piney	Fsw	Fws	Fws	Fws	Fwa
PIY /xx2x	Piney	Fsw	Fws	Fws	Fws	Fwa
PLN	Pelan	Fsw	Fw	Fw	Fw	Fw
PLN /xx1x	Pelan	Fsw	Fw	Fw	Fw	Fw
SDB	Sand Beaches	Pws	Fw	Pwi	Ps	Fw
SDBp	Sand Beaches	Vsw	Vs	Vws	Vs	Va
SDB /xcxx	Sand Beaches	Pws	Fw	Pw	Ps	Fw
SLN	Selina	Fsw	Fws	Fsw	Fw	Fw
SLN /xx1x	Selina	Fsw	Fws	Fsw	Fw	Fw
SLN /xx2x	Selina	Fwp	Fws	Fwp	Fw	Fw
SPG	Sprague	Pw	Pw	Pw	Pws	Pw

TABLE 9. SUITABILITY RATINGS OF SOILS FOR RECREATIONAL USES

Map Symbol and Phase	Soil Name	Play Ground (22)	Picnic Area (23)	Camp Area (24)	Path And Trails (25)	Permanent Bldgs. Without Basements (15)
SPGp	Sprague	Vsw	Vws	Vsw	Vws	Vw
STW	Stonewall	Fd	Fs	Fs	Fs	Fd
STW /xx3x	Stonewall	Pp	Fp	Pp	Fp	Fpd
STW /xx4x	Stonewall	Pp	Pp	Pp	Pp	Fpd

Appendix A

CORRELATION OF SOILS IN THE FRASERWOOD, INWOOD, KOMARNO AND LAKE MANITOBA SHORELINE STUDY WITH SOILS OF THE (1961) FISHER-TEULON REPORT AREA

The present soil study replaces small portions of the (1961) Fisher-Teulon study. This resurvey benefits from advantages derived through more intensive examination of soils in the field, use of a larger mapping scale to permit delineation of numerous important local soils, use of modern aerial photographs and use of improved methods of studying soils in the laboratory.

The scale of the detailed-reconnaissance map of the 1961 Fisher-Teulon study was 1:100,000 or 5/8 of an inch to one mile. This scale was not adequate to permit delineation of important local soils. Wherever individual series or phases of series, occupied continuous areas of sufficient size to be shown on the map they were mapped separately. However, in certain areas of the Fisher-Teulon study soil series frequently formed complex landscape patterns and it was often impossible to show each series separately on the small scale soil map. Where this occured, soil complexes of two or more series formed the mapping units. Mapping units were largely compound types. They were identified and described employing the soil series, the currently accepted basic unit of soil classification.

The detailed resurvey area maps at the scale of 1:20,000 or 3 inches equals approximately one mile differs considerably from the Fisher-Teulon soil maps. The large scale and more intensive examination of soils in the field has permitted the delineation of more precisely defined simple and compound mapping units whose components, soil series or phases of soil series, have less variability in terms of profile characteristics and related landscape features. In particular, differences in the stratigraphy of surface deposits, depth and type of soil profile, degree of erosion, slope or relief, stoniness and salinity were emphasized.

The correlation of the current soil series of the study area with the former soil series and complexes of the Fisher-Teulon map is outlined in Table 10.

Table 10. Correlation of Soils in the Study Area with Soils of the Detailed-Reconnaissance Soil Survey of the Fisher and Teulon Map Sheets (1961).

Resurvey		Fisher - Teulon (1961)		
Map Symbol	Soil Series and Subgroup	Series	Complex or Association	Remarks
AND	Aneda Orthic Dark Gray	Orthic Dark Gray member	Garson Association, Stonewall Complex	Parent material definition of the Garson Association and Stonewall Complex is the same as for Aneda.
BVR	Beaverdam Gleyed Dark Gray	Gleyed Dark Gray member	Polson Complex, till substrate phase	The parent material definition is the same for Beaverdam as it is for the Gleyed Dark Gray member of the Polson Complex, till substrate phase.
BYD	Berry Island Rego Humic Gleysol	Rego Humic Gleysol member	Polson Complex, till substrate phase	The Rego Humic Gleysol member of the Polson Complex, till substrate phase in shallow gravelly deposits.
CRN	Crane Terric Mesisol		Shallow peat, Chatfield Complex	The Chatfield Complex includes areas of Shallow Peat and Peaty Gleysols underlain by calcareous till, water-worked till or thin lacustrine deposits over water-worked till. The surface peat layer ranged up to 1 m. These soils are similar to the present Crane series.
GHP	Glenhope Gleyed Rego Black	Plum Ridge, till substrate, Gleyed Rego Black	Lakeland Association	Soil profile and parent material description in the same as the Plum Ridge, till substrate phase.
GRH	Garrioch Gleyed Rego Black	Gleyed Rego Black soil	Polson Complex, till substrate phase	Same as for Beaverdam, except the more common Gleyed Rego Black member.
GUO	Gunton Orthic Dark Gray	Orthic Dark Gray member	Leary Complex, till substrate	The parent material and soil profile description of the Leary till substrate phase in the Fisher-Teulon is similar to the Gunton series.
IWO	Inwood Gleyed Dark Gray	Inwood	Garson Association	The series are the same.
LUR	Lundar Gleyed Rego Black	Lundar	Isafold Association	Lundar series are equivalent in the Fisher-Teulon and resurvey.
MEB	Meleb Rego Humic Gleysol	Meleb	Garson Association	Soil profile and parent material descriptions are unchanged.

Table 10. Con't

Resurvey		Fisher - Teulon (1961)		
Map Symbol	Soil Series and Subgroup	Series	Complex or Association	Remarks
MHC	Marsh Rego Gleysol		Marsh Complex	Soil profile and parent material definitions are unchanged.
PGE	Partridge Creek Rego Humic Gleysol	Fyala, till substrate	Peguis-Arnes group	Unchanged.
PGU	Peguis Gleyed Dark Gray	Peguis, till substrate	Peguis-Arnes group	The Peguis series in the present study is equivalent to the Peguis-till substrate in the Fisher-Teulon.
PIY	Piney Gleyed Gray Luvisol		Stonewall Complex, Garson Association	Equivalent to a Gleyed Gray Luvisol Developed on the Garson and Stonewall soils.
PLN	Pelan Gleyed Dark Gray	Berlo, till substrate	Lakeland Association	Similar to the Berlo, till substrate parent material but with a Gleyed Dark Gray soil profile.
SDB	Sand Beaches Orthic Regosol		Sand Beaches	Profile and material definitions are unchanged.
SLN	Selina, Gleyed Dark Gray Luvisol	Berlo, till substrate, Gleyed Dark Gray Luvisol	Lakeland Association	Soil profile and parent material descriptions are the same for Selina and Berlo, till substrate.
SPG	Sprague Rego Humic Gleysol	Malonton, till substrate	Lakeland Association	The Sprague series is equivalent to the Malonton, till substrate meadow soil.
STW	Stonewall Orthic Dark Gray	Stonewall, rock substrate phase, Orthic Dark Gray	Stonewall Complex, Garson Association	The soil profile and parent material definitions are unchanged.

Appendix B

GUIDES FOR EVALUATING SOIL SUITABILITY FOR SELECTED USES

Table 11 Land Classification Standards for Irrigation Suitability.

Land Characteristics	Subclass	Class 1 - Very Good	Class 2 - Good	Class 3 - Fair	Class 4 - Poor
SOILS	S				
Texture					
very coarse textured very fine textured	v h	Fine sandy loams to clay loams	Loamy fine sand to light clay	Sand to permeable clay	Gravel to clay
Water holding capacity					
low available moisture capacity	q	40 to 60 sat. % >15cm storage in 1.2m <10cm/hr. hydraulic cond.	35 to 65 sat. % >12.5cm storage in 1.2m <12.5cm/hr. hydraulic cond.	25 to 75 sat. % >7.5cm storage in 1.2m <17.5cm/hr. hydraulic cond.	<25 or >75 sat. % <7.5cm storage in 1.2m >17.5cm/hr. hydraulic cond.
Geological Deposit					
shallow deposit over sand or gravel	k	.9m or more of fine sandy loam or heavier	.6m or more of fine sandy loam or heavier, or .75m plus of loamy fine sand or sandy loam	.5m or more of sandy loam or heavier, or .6m plus of loamy sand	<.5m of sandy loam or heavier, or .6m of loamy sand or sand
shallow deposit over impervious substrata	b	>3m of permeable material	>2m of permeable material	>1m of permeable material	<1m of permeable material
Salinity and Alkalinity[1,2]	a	<4 ms/cm in 0-.6m <8 ms/cm below .6m <6 S.A.R.	<4 ms/cm in 0-.6m <12 ms/cm below .6m <8 S.A.R.	<8 ms/cm in 0-.6m <15 ms/cm below .6m <12 S.A.R.	>8 ms/cm in 0-.6m >15 ms/cm below .6m >12 S.A.R.
EXTERNAL FEATURES					
Stones - rock clearing	r	None to light clearing	Light to medium clearing	Light to heavy clearing	Excessively stony
Topography Slope excess gradient	T	g <1% and 0.1% in general gradient (0-3% slope)	<3% in general gradient (3-5% slope)	<5% in general gradient (5-10% slope)	>5% in general* gradient (>10% slope)**
DRAINAGE	D				
restricted outlet		No problem anticipated	Moderate drainage problem anticipated but may be improved at relatively low cost	Moderate to severe drainage problem anticipated but may be improved by expensive but feasible measures	Drainage improvement not considered feasible
water table		below 2.4m most of year	could be above 1.5m for a short period, then recedes to 2.4m or lower	within 1.5m most of year	within 1m most of year

---

* Criteria for gravity (flood) irrigation requirements.

** Estimated adjustments to slope criteria for overhead or sprinkler type irrigation methods.

[1] If sufficient gypsum is present in the soil, the S.A.R. may be lowered by leaching the soil (a very slow process), and the hydraulic conductivity may then improve.

[2] The degree of salinity may vary widely within short distances, and there may be no clear indication of the area occupied by each salinity class. Unless a very detailed mapping and sampling program is carried out, it is impossible to estimate the acreage occupied by each salinity class.

Table 12 Guide for assessing soil suitability as source of topsoil.

The term "topsoil" includes soil materials used to cover barren surfaces exposed during construction, and materials used to improve soil conditions on lawns, gardens, flower beds, etc. The factors to be considered include not only the characteristics of the soil itself, but also the ease or difficulty of excavation, and where removal of topsoil is involved, accessibility to the site.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
u	Moist Consistence[2]	Very friable, friable	Loose, firm	Very firm	Cemented
i	Flooding	None	May flood occasionally for short periods	Frequent flooding	Constantly flooded
w	Wetness[2]	Wetness is not determining if better than very poorly drained.			Very poorly drained and permanently wet soils
t	Slope	0-5%	5-9%	9-15%	>15%
p	Stoniness[2]	Stones 10 m apart (Class 0 and 1)	Stones 2-10 m apart (Class 2)	Stones 0.1-2 m apart (Class 3 and 4)	Stones 0.1 m apart (Class 5)
c	Coarse fragments[2]: percent, by volume	<3%	3-15%	15-35%	>35%
s	Texture[2]	FSL, VFSL, L, SiL, SL, SC if 1:1 clay is dominant	CL, SCL, SiCL, SC if 2:1 clay is dominant; c and sic if 1:1 clay is dominant	S, LS, C and SiC if 2:1 clay is dominant. organic soils[3]	Marl, diatomaceous earth
b	Depth of Topsoil[4]	>40 cm	15-40 cm	8-15 cm	<8 cm
n	Salinity of Topsoil[5]	E.C. 0-1	E.C. 1-4	E.C. 4-8	E.C. >8

[1] The symbols are used to indicate the nature of the limitation.

[2] For an explanation of texture, consistence, stoniness, coarse fragments and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

[3] Non-woody organic materials are assessed as good sources for topsoil if mixed with or incorporated into mineral soil.

[4] The remaining soil material (at least 8 cm) must be reclaimable after the uppermost soil is removed.

[5] E.C. = Electrical Conductivity (millisiemens/cm).

Table 13. Guide for assessing soil suitability as source of sand and gravel.

The purpose of this table is to provide guidance for assessing the probable supply as well as quality of the sand or gravel for use as road base material and in concrete. The interpretation pertains mainly to the characteristics of the soil substratum to a depth of 150 cm, augmented by observations made in deep cuts as well as geological knowledge where available.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
a	Unified Soil Group	SW SP GW GP	SW-SM SP-SM GP-GM GW-GM	SM SW-SC SP-SC GM GP-GC GW-GC	All other groups and bedrock
h	Depth to Seasonal Water Table	Not class determining if deeper than 50 cm		50 cm	
q	Depth to Sand and Gravel	<25 cm	25-75 cm[2]	>75 cm[2]	
p	Stoniness[3]	Not class determining if stones >.5 m apart (Class 0, 1, 2 and 3)		Stones 0.1-0.5 m apart (Class 4)	Stones <0.1 m apart (Class 5)
d	Depth to Bedrock	>100 cm	50-100 cm	<50 cm	

[1] The symbols are used to indicate the nature of the limitation.

[2] Rated good if it is known that the underlying gravel or sand deposit is thick (>100 cm).

[3] For an explanation of stoniness and rockiness, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

Table 14. Guide for assessing soil suitability as source of roadfill.

Fill material for buildings or roads are included in this use. The performance of the material when removed from its original location and placed under load at the building site or road bed are to be considered. Since surface materials are generally removed during road or building construction their properties are disregarded. Aside from this layer, the whole soil to a depth of 150-200 cm should be evaluated. Soil materials which are suitable for fill can be considered equally suited for road subgrade construction.

Symbol[1]	Items Affecting Use[2]	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
a	Subgrade[3]				
	a. AASHO group index[4]	0-4	5-8	>8	
	b. Unified soil classes	GW, GP, SW, SP, SM, GC[5] and SC[5]	CL (with P.I.[6] <15) and ML	CL (with P.I.[6] of 15 or more), CH and MH[7]	OL, OH and Pt
l	Shrink-swell potential	Low	Moderate	High	
f	Susceptibility to frost action[8]	Low	Moderate	High	
t	Slope	0-15%	15-30%	30-45%	>45%
p	Stoniness[9]	Stones >2 m apart (Class 0, 1 and 2)	Stones 0.5-2 m apart (Class 3)	Stones 0.1-0.5 m apart (Class 4)	Stones <0.1 m apart (Class 5)
r	Rockiness[9]	Rock exposures >35 m apart and cover <10% of the surface	Rock exposure 10-35 m apart and cover 10-25% of the surface	Rock exposure 3.5-10 m apart and cover 25-50% of the surface	Rock exposures <3.5 m apart and cover 50-90% of the surface
w	Wetness[9]	Excessively drained to moderately well drained	Imperfectly drained	Poorly drained	Very poorly drained or permanently wet soils
d	Depth to Bedrock	>100 cm	50-100 cm	20-50 cm	<20 cm
h	Depth to Seasonal Water Table	>150 cm	75-150 cm	50-75 cm	<50 cm

---

[1] The symbols are used to indicate the nature of the limitation.

[2] The first three items pertain to soil after it is placed in a fill; the last six items pertain to soil in its natural condition before excavation for road fill.

[3] This item estimates the strength of the soil material, that is, its ability to withstand applied loads.

[4] Use AASHO group index only where laboratory data are available for the kind of soil being rated; otherwise, use Unified soil groups.

[5] Downgrade suitability rating to fair if content of fines is more than about 30 percent.

[6] P.I. means plasticity index.

[7] Upgrade suitability rating to fair if MH is largely kaolinitic, friable, and free of mica.

[8] Use this item only where frost penetrates below the paved or hardened surface layer and where moisture transportable by capillary movement is sufficient to form ice lenses at the freezing front.

[9] For an explanation of stoniness, rockiness and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

Table 15. Guide for assessing soil suitability for permanent buildings[1].

This guide applies to undisturbed soils to be evaluated for single-family dwellings and other structures with similar foundation requirements. The emphasis for rating soils for buildings is on foundation requirements; but soil slope, susceptibility to flooding and other hydrologic conditions, such as wetness, that have effects beyond those related exclusively to foundations are considered too. Also considered are soil properties, particularly depth to bedrock, which influence excavation and construction costs for the building itself and for the installation of utility lines. Excluded are limitations for soil corrosivity, landscaping and septic tank absorption fields.

Symbol[2]	Items Affecting Use	Degree of Soil Suitability[3]			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[4]	With Basements: Very rapidly, rapidly and well drained. Without Basements: Very rapidly, rapidly, well and moderately well drained.	With Basements: Moderately well drained. Without Basements: Imperfectly drained.	With Basements: Imperfectly, poorly, and very poorly drained. Without Basements: Poorly and very poorly drained.	With Basements: Permanently wet soils. Without Basements: Permanently wet soils.
h	Depth to Seasonal Water Table	With Basements: >150 cm Without Basements: >75 cm	With Basements: 75-150 cm Without Basements: 50-75 cm	With Basements: 25-75 cm Without Basements: 25-50 cm	With Basements: <25 cm Without Basements: <25 cm
i	Flooding	None	None	Occasional flooding (once in 5 years)	Frequent flooding (every year)
t	Slope[5]	0-9%	9-15%	15-30%	>30%
s	Subgrade[6]				
	a. AASHO group index[7]	0-4	5-8	>8	
	b. Unified soil classes	GW, GP, SW, SP, SM and GC and SC	CL (with P.I.[8] <15) and ML	CL (with P.I.[8] of 15 or more), CH and MH	OH, OL and Pt
f	Potential Frost Action[9]	Low (F1, F2)	Moderate (F3)	High (F4)	
p	Stoniness[4]	Stones >10 m apart (Class 0 to 1)	Stones 2-10 m apart (Class 2[10])	Stones 0.1-2 m apart (Class 3[10] to 4)	Stones <0.1 m apart (Class 5[10])
r	Rockiness[4],[11]	Rock exposures >100 m apart and cover <2% of the surface	Rock exposures 30-100 m apart and cover 2-10% of the surface	Rock exposures <30 m apart and cover >10% of the surface	Rock exposures too frequent to allow location of permanent buildings
d	Depth to Bedrock[11]	With Basements: >150 cm Without Basements: >100 cm	With Basements: 100-150 cm Without Basements: 50-100 cm	With Basements: 50-100 cm Without Basements: <50 cm	With Basements: <50 cm

---

[1] By halving the slope limits, this table can be used for evaluating soil suitability for buildings with large floor areas, but with foundation requirements not exceeding those of ordinary three-storey dwellings.

[2] The symbols are used to indicate the nature of the limitation.

[3] Some soils assessed as fair or poor may be good sites from an aesthetic or use standpoint, but they will require more site preparation and/or maintenance.

[4] For an explanation of rockiness, stoniness and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

[5] Reduce the slope limits by one half for those soils subject to hillside slippage.

[6] This item estimates the strength of the soil, that is, its ability to withstand applied loads. When available, AASHO Group Index values from laboratory tests were used; otherwise the estimated Unified classes were used.

[7] Group index values were estimated from information published by the Portland Cement Association (PCA, 1962), pp. 23-25.

[8] P.I. means plasticity index.

[9] Frost heave only applies where frost penetrates to the assumed depth of the footings and the soil is moist. The potential frost action classes are taken from the United States Army Corps of Engineers (1962), pp. 5-8.

[10] Rate one class better for buildings without basements.

[11] Rate one class better if the bedrock is soft enough so that it can be dug with light power equipment such as backhoes.

Table 16. Guide for assessing soil suitability for local roads and streets[1].

This guide applies to soils to be evaluated for construction and maintenance of local roads and streets. These are improved roads and streets having some kind of all-weather surfacing, commonly asphalt or concrete, and are expected to carry automobile traffic all year. They consist of: (1) the underlying local soil material (either cut or fill) called the subgrade; (2) the base material of gravel, crushed rock, or lime or soil cement stabilized soil called the subbase; and (3) the actual road surface or pavement, either flexible or rigid. They also are graded to shed water and have ordinary provisions for drainage. With the probable exception of the hardened surface layer, the roads and streets are built mainly from the soil at hand, and cuts and fills are limited, usually less than 2 meters. Excluded from consideration in this guide are highways designed for fast-moving, heavy trucks.

Properties that affect design and construction of roads and streets are: (1) those that affect the load supporting capacity and stability of the subgrade, and (2) those that affect the workability and amount of cut and fill. The AASHO and Unified Classification give an indication of the traffic supporting capacity. Wetness and flooding affect stability. Slope, depth of hardrock, stoniness, rockiness, and wetness affect the ease of excavation and the amount of cut and fill to reach an even grade.

Symbol[2]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[3]	Very rapidly, rapidly, well and moderately well drained	Imperfectly drained	Poorly and very poorly drained	Permanently wet soils
i	Flooding	None	Infrequent (once in 5 years)	Occasional (once in 2-4 years)	Frequent (every year)
t	Slope	0-9%	9-15%	15-30%	>30%
d	Depth to Bedrock[4]	>100 cm	50-100 cm	<50 cm	
a	Subgrade[5]				
	a. AASHO group index[6]	0-4	5-8	>8	
	b. Unified soil classes	GW, GP, SW, SP, SM, GC[7] and SC[7]	CL (with P.I.[8] <15) and ML	CL (with P.I.[8] of 15 or more), CH and MH	OH, OL and Pt
f	Susceptibility to Frost Heave[9]	Low (F1, F2)	Moderate (F3)	High (F4)	
p	Stoniness[3]	Stones >2 m apart (Class 0 to 2)	Stones 0.5-2 m apart (Class 3)	Stones 0.1-0.5 m apart (Class 4)	Stones <0.1 m apart (Class 5)
r	Rockiness[3]	Rock exposures >100 m apart and cover <2% of the surface	Rock exposures 30-100 m apart and cover 2-10% of the surface	Rock exposures <30 m apart and cover >10% of the surface	Rock exposures too frequent to permit location of roads and streets

[1] These guidelines, with some adjustment of slope and rockiness limits, will also be useful for assessing soils for use as parking lots.

[2] Symbols are used to indicate the nature of the limitation.

[3] For an explanation of stoniness, rockiness and soil drainage classes, see the Canada Soil Information System (Canada Soil Survey Committee, 1978).

[4] Rate one class better if the bedrock is soft enough so that it can be dug with light power equipment and is rippable by machinery.

[5] This item estimates the strength of soil materials as it applies to roadbeds. When available, AASHO Group Index values from laboratory tests were used; otherwise, the estimated Unified classes were used. The limitations were estimated assuming that the roads would be surfaced. On unsurfaced roads, rapidly drained, very sandy, poorly graded soils may cause washboard or rough roads.

[6] Group index values were estimated from information published by the Portland Cement Association (PCA, 1962) pp. 23-25.

[7] Downgrade to moderate if content of fines (less than 200 mesh) is greater than about 30 percent.

[8] P.I. means plasticity index.

[9] Frost heave is important where frost penetrates below the paved or hardened surface layer and moisture transportable by capillary movement is sufficient to form ice lenses at the freezing point. The susceptibility classes are taken from the United States Army Corps of Engineers (1962) pp. 3-8.

Table 17. Guide for assessing soil suitability for trench-type sanitary landfills[1].

The trench-type sanitary landfill is a sanitary landfill, in which dry garbage and trash is buried daily in an open trench and covered with a layer of soil material. Suitability of the site is dependent upon the potential for pollution of water sources through groundwater contact with the refuse, or leachate arising from the site. Those properties affecting ease of excavation of the site must be supplemented with geological and hydrological knowledge to provide subsurface soil and groundwater data to a depth of at least 3 to 4.5 m, a common depth of landfills.

Symbol[2]	Items Affecting Use	Degree of Soil Suitability			
		Good - G[3]	Fair - F	Poor - P	Very Poor - V
h	Depth to Seasonal High Water Table	Not class determining if more than 180 cm		100-180 cm	<100 cm
w	Wetness[4]	Not class determining if better than imperfectly drained		Imperfectly drained	Poorly and very poorly drained or permanently wet soils
i	Flooding	None	Rare	Occasional	Frequent
k	Permeability[5]	<5 cm/hr	<5 cm/hr	5-15 cm/hr	>15 cm/hr
t	Slope	0-15%	15-30%	30-45%	>45%
s	Soil Texture[4],[6] (dominant to a depth of 150 cm)	SL, L, SiL, SCL	SiCL[7], CL, SC, LS	SiC, C	Muck, peat, gravel, sand
d	Depth to Hard Bedrock Rippable	>150 cm >150 cm	>150 cm 100-150 cm	100-150 cm 100-150 cm	<100 cm <100 cm
p	Stoniness[4]	Stones >10 m apart (Class 0 and 1)	Stones 2-10 m apart (Class 2)	Stones 0.1-2 m apart (Class 3 and 4)	Stones <0.1 m apart (Class 5)
r	Nature of Bedrock	Impermeable			Highly permeable, fractured, easily soluble

---

[1] Based on soil depth (120 cm) commonly investigated in making soil surveys.

[2] The symbols are used to indicate the nature of the limitation.

[3] If probability is high that the soil material to a depth of 3 to 4.5 m will not alter a rating of good or fair, indicate this by an appropriate footnote, such as "Probably good to a depth of 3.5 m", or "Probably fair to a depth of 3.5 m".

[4] For an explanation of stoniness, texture and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

[5] Reflects ability of soil to retard movement of leachate from the landfills; may not reflect a limitation in arid and semiarid areas.

[6] Reflects ease of digging and moving (workability) and trafficability in the immediate area of the trench where there may not be surfaced roads.

[7] Soils high in expansive clays may need to be given a suitability rating of poor.

Table 18. Guide for assessing soil suitability for area-type sanitary landfills.

In the area-type sanitary landfill refuse is placed on the surface of the soil in successive layers. The daily and final cover material generally must be imported. A final cover of soil material at least 60 cm thick is placed over the fill when it is completed.

The soil under the proposed site should be investigated so as to determine the probability that leachates from the landfill can penetrate the soil and thereby pollute water supplies.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
h	Depth to Seasonal Water Table[2]	>150 cm	150-100 cm	50-100 cm	<50 cm
w	Wetness[2],[3]	Rapid to moderately well drained	Imperfectly drained	Poorly drained	Very poorly drained or permanently wet soils
i	Flooding	None	Rare	Occasional	Frequent
k	Permeability[4],[5]	Not class determining if less than 5 cm/hr		5-15 cm/hr	>15 cm/hr
t	Slope	0-9%	9-15%	15-30%	>30%

---

[1] The symbols are used to indicate the nature of the limitation.

[2] Reflects influence of wetness on operation of equipment.

[3] For an explanation of drainage, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

[4] Reflects ability of the soil to retard movement of leachate from landfills; may not reflect a limitation in arid and semiarid areas.

[5] Due to possible groundwater contamination, impermeable bedrock is considered poor and permeable bedrock is rated very poor for area-type sanitary landfills.

Table 19. Guide for assessing soil suitability as cover material for area-type sanitary landfills.

The term cover material includes soil materials used to put a daily and final covering layer on refuse in area-type sanitary landfills. This cover material may be derived from the area of the landfill or may be brought in from surrounding areas.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
u	Moist Consistence[2]	Very friable, friable	Loose, firm	Very firm	Cemented
s	Texture[2],[3]	SL, L, SiL, SCL	SiCL, CL, SC, LS	SiC, C	Muck, peat, sand, gravel
d	Depth to bedrock[4]	>150 cm	100-150 cm	50-100 cm	<50 cm
c	Coarse fragments[2]	<15%	15-35%	>35%	
p	Stoniness[2]	Stones >10 m apart (Class 0 and 1)	Stones 2-10 m apart (Class 2)	Stones 0.1-2 m apart (Class 3 and 4)	Stones <0.1 m apart (Class 5)
t	Slope	<9%	9-15%	15-30%	>30%
w	Wetness[2]	Not class determining if better than poorly drained		Poorly drained	Very poorly drained or permanently wet soils

[1] The symbols are used to indicate the nature of the limitation.

[2] For an explanation of consistence, texture, coarse fragments, stoniness and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

[3] Soils having a high proportion of non-expansive clays may be given a suitability rating one class better than is shown for them in this table.

[4] Thickness of material excluding topsoil, which will be stockpiled (see guide for topsoil).

Table 20. Guide for assessing soil suitability for reservoirs and sewage lagoons.

Factors affecting the ability of undisturbed soils to impound water or sewage and prevent seepage are considered for evaluating soils on their suitability for reservoir and lagoon areas. This evaluation considers soil both as a vessel for the impounded area and as material for the enclosing embankment. As the impounded liquids could be potential sources of contamination of nearby water supplies, e.g. sewage lagoons, the landscape position of the reservoir as it affects risk of flooding must also be considered.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
h	Depth to Water Table[2]	>150 cm	100-150 cm	50-100 cm	<50 cm
i	Flooding[3]	None	None	Subject to infrequent flooding (once in 50 years)	Subject to frequent high level flooding
k	Soil Permeability	0-0.5 cm/hr	0.5-5 cm/hr	5-15 cm/hr	>15 cm/hr
t	Slope	0-2%	2-5%	5-9%	>9%
o	Organic Matter	<2%	2-10%	10-30%	>30%
c	Coarse Fragments[4] <25 cm in diameter, % by volume	<20%	20-35%	>35%	
p	Stoniness[4], >25 cm diameter, percent of surface area	<3% (Class 0, 1 and 2)	3-15% (Class 3)	15-50% (Class 4)	>50% (Class 5)
d	Depth to Bedrock[5]	>150 cm	100-150 cm	50-100 cm	<50 cm
j	Thickness of Slowly Permeable Layer	>100 cm	50-100 cm	50-25 cm	<25 cm
a	Subgrade Unified Soil Classes	GC, SC, CL, & CH	GM, ML, SM & MH	SW & SP	OL, OH & Pt GP, GW

[1] The symbols are used to indicate the nature of the limitation.

[2] If the floor of the lagoon has nearly impermeable material at least 50 cm thick, disregard depth to water table.

[3] Disregard flooding if it is not likely to enter or damage the lagoon (flood waters have low velocity and depth less than 150 cm).

[4] For an explanation of coarse fragments and stoniness classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

[5] Surface exposures of non rippable rock are rated very poor. If underlying bedrock is impermeable, rating should be one class better.

Table 21. Guide for assessing soil suitability for septic tank absorption fields.

This guide applies to soils to be used as an absorption and filtering medium for effluent from septic tank systems. A subsurface tile system laid in such a way that effluent from the septic tank is distributed reasonably uniformly into the natural soil is assumed when applying this guide. A rating of poor need not mean that a septic system should not be installed in the given soil, but rather, may suggest the difficulty, in terms of installation and maintenance, which can be expected.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
k	Permeability[2]	Rapid to moderately rapid	Moderate	Slow	Very slow
	Percolation Rate[3] (Auger hole method)	About 8-18 min/cm[3]	18-24 min/cm	Slower than 24 min/cm	
h	Depth to Seasonal Water Table[4]	>150 cm[5]	100-150 cm	50-100 cm	<50 cm
i	Flooding	Not subject to flooding	Not subject to flooding	Subject to occasional flooding (once in 5 years)	Floods every year
t	Slope	0-9%	9-15%	15-30%	>30%
d	Depth to Hard Rock, bedrock or other impervious materials	>150 cm	100-150 cm[6]	50-100 cm	<50 cm

[1] The symbols are used to indicate the nature of the limitation.

[2] The suitability ratings should be related to the permeability of soil layers at and below depth of the tile line.

[3] Soils having a percolation rate less than about 8 min/cm are likely to present a pollution hazard to adjacent waters. This hazard must be noted, but the degree of hazard must, in each case, be assessed by examining the proximity of the proposed installation to water bodies, water table, and related features. The symbol g is used to indicate this condition. Refer to U.S. Dept. of Health, Education and Welfare (1969) for details of this procedure.

[4] Seasonal means for more than one month. It may, with caution, be possible to make some adjustment for the severity of a water table limitation in those cases where seasonal use of the facility does not coincide with the period of high water table.

[5] A seasonal water table should be at least 100 cm below the bottom of the trench at all times for soils rated Good (U.S. Dept. of Health, Education and Welfare, 1969). The depths used to water table are based on an assumed tile depth of 50 cm. Where relief permits, the effective depth above a water table or rock can be increased by adding appropriate amounts of fill.

[6] Where the slope is greater than 9%, a depth to bedrock of 100-150 cm is assessed as poor.

Table 22. Guide for assessing soil suitability for playgrounds.

This guide applies to soils to be used intensively for playgrounds for baseball, football, badminton, and for other similar organized games. These areas are subject to intensive foot traffic. A nearly level surface, good drainage, and a soil texture and consistence that gives a firm surface generally are required. The most desirable soils are free of rock outcrops and coarse fragments.

Soil suitability for growing and maintaining vegetation is not a part of this guide, except as influenced by moisture, but is an important item to consider in the final evaluation of site.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[2]	Rapidly, well and moderately well drained soils with no ponding or seepage. Water table below 75 cm during season of use.	Moderately well drained soils subject to occasional seepage or ponding of short duration and imperfectly drained soils. Water table below 50 cm during season of use.	Imperfectly drained soils subject to seepage or ponding, and poorly drained soils. Water table above 50 cm during season of use.	Very poorly drained and permanently wet soils.
i	Flooding	None during season of use.	Occasional flooding. May flood once every 2-3 years during season of use.	Floods every year during season of use.	Prolonged flooding during season of use.
k	Permeability	Very rapid to moderate.	Moderately slow and slow.	Very slow.	
t	Slope	0-2%	2-5%	5-9%	>9%
d	Depth to Bedrock	>100 cm	50-100 cm[3]	<50 cm[3]	
c	Coarse fragments on surface[2]	Relatively free of coarse fragments.	<20% coarse fragments.	>20% coarse fragments.	
p	Stoniness[2]	Stones >10 m apart. (Class 0 to 1)	Stones 2-10 m apart. (Class 2)	Stones 0.1-2 m apart. (Class 3, 4)	Stones <0.1 m apart. (Class 5)
r	Rockiness[2]	Rock exposures >100 m apart and cover <2% of the surface.	Rock exposures 30-100 m apart and cover about 2-10% of the surface.	Rock exposures <30 m apart and cover >10% of the surface.	Rock outcrops too frequent to permit playground location.
s	Surface Soil Texture[2],[4]	SL, FSL, VFSL, L	SiL, CL, SCL, SiCL, LS	SC, SiC, C[5]; S, Si	Peaty soils; S and LS subject to blowing.
q	Depth to Sand or Gravel[6]	>100 cm	50-100 cm	<50 cm	
m	Useful Moisture[7]	Water storage capacity[8] >15.0 cm and/or adequate rainfall and/or low evapotranspiration.	Water storage capacity[8] 7.5-15 cm and/or moderate rainfall and/or moderate evapotranspiration.	Water storage capacity[8] <7.5 cm and/or low rainfall and/or high evapotranspiration.	

---

[1] The symbols are used to indicate the nature of the limitation.

[2] See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).
Coarse fragments for the purpose of this table include gravels and cobbles.

[3] Downgrade to a very poor suitability rating if the slope is greater than 5%.

[4] Surface soil texture influences soil ratings as it affects foot trafficability, surface wetness, dust, and maintenance. Adverse soil textures may be partially or completely overcome with the addition of topsoil.

[5] Moderately well and well drained SC, SiC and C soils may be rated fair.

[6] Depth to sand or gravel is considered a limitation in that levelling operations may expose sand or gravel, thereby bringing about adverse surface textures and undesirable amounts of coarse fragments. The addition of topsoil after the levelling process would overcome this limitation.

[7] This item attempts to evaluate the adequacy of moisture for vegetative growth. It incorporates the concept of supply through rainfall, loss through evapotranspiration, and storage within the rooting zone. In soils where the water table is within rooting depth for a significant portion of the year, water storage capacity may not significantly influence vegetation growth.

[8] Consult glossary for definitions of terms used.

Table23. Guide for assessing soil suitability for picnic areas.

This guide applies to soils considered for intensive use as park-type picnic areas. It is assumed that most vehicular traffic will be confined to the access roads. Soil suitability for growing and maintaining vegetation is not a part of this guide, except as influenced by moisture, but is an important item to consider in the final evaluation of site.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[2]	Very rapidly, rapidly, well and moderately well drained soils not subject to seepage or ponding. Water table below 50 cm during season of use.	Moderately well drained soils subject to occasional seepage or ponding and imperfectly drained soils not subject to ponding or seepage. Water Table above 50 cm for short periods during season of use.	Imperfectly drained soils subject to seepage or ponding. Poorly drained soils. Water table above 50 cm and often near surface for a month or more during season of use.	Very poorly drained and permanently wet soils.
i	Flooding	None during season of use.	May flood 1 or 2 times per year for short periods during season of use.	Floods more than 2 times during season of use.	Prolonged flooding during season of use.
t	Slope	0-9%	9-15%	15-30%	>30%
s	Surface Soil Texture[2],[3]	SL, FSL, VFSL, L	SiL, CL, SCL, SiCL, LS, and sand other than loose sand.	SC, SiC, C[4]; Si	Peaty soils; loose sand subject to blowing.
c	Coarse Fragments on Surface[2]	0-20%	20-50%	>50%	
p	Stoniness[2]	Stones >2 m apart (Class 0 to 2)	Stones 1-2 m apart (Class 3)	Stones 0.1-1 m apart (Class 4)	Stones <0.1 m apart (Class 5)
r	Rockiness[2],[5],[6]	Rock exposures roughly 30-100 or more m apart and cover <10% of the surface.	Rock exposures roughly 10-30 m apart and cover 10-25% of the surface.	Rock exposures <10 m apart and cover >25% of the surface.	Rock exposures too frequent to permit location of picnic areas.
m	Useful Moisture[7]	Water storage capacity[8] >15 cm and/or adequate rainfall and/or low evapotranspiration.	Water storage capacity[8] 7.5-15 cm and/or moderate rainfall and/or moderate evapotranspiration.	Water storage capacity[8] <7.5 cm and/or low rainfall and/or high evapotranspiration.	

---

[1] The symbols are used to indicate the nature of the limitation.

[2] See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978). Coarse fragments for the purpose of this table, include gravels and cobbles. Some gravelly soils may be rated as having a slight limitation if the content of gravel exceeds 20% by only a small margin providing (a) the gravel is embedded in the soil matrix, or (b) the fragments are less than 2 cm in size.

[3] Surface soil texture influences soil ratings as it affects foot trafficability, dust and soil permeability.

[4] Moderataly well and well drained SC, SiC and C soils may be rated fair.

[5] Very shallow soils are rated as having severe or very severe limitations for stoniness or rockiness.

[6] The nature and topography of the bedrock exposures may significantly alter these ratings. As such, on-site investigations will be necessary in map units containing bedrock when these are considered as possible sites.

[7] This item attempts to evaluate the adequacy of moisture for vegetative growth. It incorporates the concept of supply through rainfall, loss through evapotranspiration, and storage within the rooting zone. In soils where the water table is within rooting depth for a significant portion of the year, water storage capacity may not significantly influence vegetation growth.

[8] Consult glossary for definitions of terms used.

Table 24. Guide for assessing soil suitability for camp areas.

This guide applies to soils to be used intensively for tents and camp trailers and the accompanying activities of outdoor living. It is assumed that little site preparation will be done other than shaping and levelling for campsites and parking areas. The soil should be suitable for heavy foot traffic by humans and limited vehicular traffic. Soil suitability for growing and maintaining vegetation is not a part of this guide, but is an important item to consider in the final evaluation of site.

Back country campsites differ in design, setting and management but require similar soil attributes. These guides should apply to evaluations for back country campsites but depending on the nature of the facility the interpreter may wish to adjust the criteria defining a given degree of limitation to reflect the changed requirement. For example, small tentsites may allow rock exposures greater than 10 m apart to be considered a slight limitation.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[2]	Very rapidly, rapidly, well and moderately well drained soils with no seepage or ponding. Water table below 75 cm during season of use.	Moderately well drained soils subject to occasional seepage or ponding and imperfectly drained soils with no seepage or ponding. Water table below 50 cm during season of use.	Imperfectly drained soils subject to seepage or ponding and poorly drained soils. Water table above 50 cm during season of use.	Very poorly drained and permanently wet soils.
i	Flooding	None	Very occasional flooding during season of use. Once in 5-10 years.	Occasional flooding during season of use. Once in 2-4 years.	Flooding during every season of use.
k	Permeability	Very rapid to moderate inclusive.	Moderately slow and slow.	Very slow.	
t	Slope	0-9%	9-15%	15-30%	>30%
s	Surface Soil Texture[2,3]	SL, FSL, VFSL, L	SiL, SCL, CL, SiCL, LS, and sand other than loose sand.	SC, SiC, C[4]; Si	Peaty soils; loose sand subject to blowing.
c	Coarse Fragments on Surface[2,5]	0-20%	20-50%	>50%	
p	Stoniness[2,6]	Stones >10 m apart (Class 0 and 1)	Stones 2-10 m apart (Class 2)	Stones 0.1-2 m apart (Class 3 and 4)	Stones < 0.1 m apart (Class 5)
r	Rockiness[2,6]	No rock exposures	Rock exposures >10 m apart and cover <25% of the area.	Rock exposures <10 m apart and cover >25% of the area.	Rock exposures too frequent to permit campground location.

---

[1] The symbols are used to indicate the nature of the limitation.

[2] See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

[3] Surface soil texture influences soil ratings as it affects foot trafficability, dust, and soil permeability.

[4] Moderately well and well drained SC, SiC and C soils may be rated fair.

[5] Coarse fragments for the purpose of this table include gravels and cobbles. Some gravelly soils may be rated as having slight limitations if the content of gravel exceeds 20% by only a small margin, providing (a) the gravel is embedded in the soil matrix, or (b) the fragments are less than 2 cm in size.

[6] Very shallow soils are rated as having a limitation for rockiness and/or stoniness.

Table 25. Guide for assessing soil suitability for paths and trails.

It is assumed that the trails will be built at least 45 cm wide and that obstructions such as cobbles and stones will be removed during construction. It is also assumed that a dry, stable tread is desirable and that muddy, dusty, worn or eroded trail treads are undesirable. Hiking and riding trails are not treated separately, but as the design requirements for riding trails are more stringent, a given limitation will be more difficult to overcome. Poor or very poor suitability does not indicate that a trail cannot or should not be built. It does, however, suggest higher design requirements and maintenance to overcome the limitations.

Symbol[1]	Items[2] Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
s	Texture[3],[4]	SL, FSL, VFSL, LS, L	SiL, CL, SiCL, SCL	SC, SiC, C[5]; Sand, Si	Peaty soils; loose sand subject to blowing
c	Coarse Fragment Content[4],[6]	0-20%	20-30%	>30%	
p	Stoniness[4]	Stones >2 m apart (Class 0 to 2)	Stones 1-2 m apart (Class 3)	Stones 0.1-1 m apart (Class 4)	Stones <0.1 m apart (Class 5)
w	Wetness[4]	Very rapidly, rapidly well, and moderately well drained soils. Water table below 50 cm during season of use.	Moderately well drained soils subject to occasional seepage and ponding and imperfectly drained soils. Water table may be above 50 cm for short periods during season of use.	Poorly and very poorly drained soils. Water table above 50 cm and often near surface for a month or more during season of use.	Permanently wet soils.
r	Rockiness[4],[7]	Rock exposures >30 m apart and cover <10% of the surface.	Rock exposures 10-30 m apart and cover 10-25% of the surface.	Rock exposures <10 m apart and cover >25% of the surface.	Rock exposures too frequent to permit location of paths and trails.
t	Slope[8]	0-15%	15-30%	30-60%	>60%
i	Flooding	Not subject to flooding during season of use.	Floods 1 or 2 times during season of use.	Floods more than 2 times during season of use.	Subject to prolonged flooding during season of use.

---

[1] The symbols are used to indicate the nature of the limitation.

[2] The items affecting use listed in this table are those which have been shown to cause significant differences in trail response. Elevation, aspect, position on slope, and snow avalanching may have slight effects or influence trail management and should be considered in the final site evaluation. Items such as vegetation, fauna, and scenic value are not considered in the guidelines (Epp, 1977).

[3] Texture refers to the soil texture which will form the tread texture. This is the surface texture on level areas but may be a subsurface texture on slopes. Textural classes are based on the less than 2 mm soil fraction. Texture influences soil ratings as it influences foot trafficability, dust, design or maintenance of trails, and erosion hazards.

[4] See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

[5] Moderately well and well drained SC, SiC and C soils may be rated fair.

[6] Coarse fragments for the purpose of this table, include gravels and cobbles. Gravels tend to cause unstable footing when present in high amounts, and are also associated with increased erosion. Cobbles (and stones) must be removed from the trail tread, increasing construction and maintenance difficulties. Some gravelly soils may be rated as having a slight limitation if the content of gravel exceeds 20% by only a small margin providing (a) the gravel is embedded in the soil matrix or (b) the fragments are less than 2 cm in size.

[7] The type of rock outcrop (flat lying vs cliffs), and the orientation of the structure (linear cliffs vs massive blocks) can greatly alter the degree of the limitation. Each site with a Rockiness limitation based on the percent rock outcrop above should be evaluated on its own merits and the degree of limitation should then be modified appropriately if necessary.

[8] Slope in this context refers to the slope of the ground surface, not the slope of the tread.

Appendix C

GLOSSARY

AASHO classification (soil engineering) - The official classification of soil materials and soil aggregate mixtures for highway construction used by the American Association of State Highway Officials.

Acid soil - A soil having a pH less than 7. See pH and Reaction, soil.

Alkaline soil - A soil having a pH greater than 7. See Reaction, soil.

Alluvium - A general term for all deposits of rivers and streams.

Arable soil - Soil suitable for plowing and cultivation.

Association - A sequence of soils of about the same age, derived from similar parent material, and occuring under similar climatic conditions but showing different characteristics due to variations in relief and in drainage.

1/3 Atmosphere Moisture - The moisture percentage on dry weight basis of a soil sample that has been air dried, screened, saturated and subjected to a soil moisture tension of 345 cm of water through a permeable membrane for a period of 48 hours. It approximates the soil moisture retention capacity.

Available nutrient - That portion of any element or compound in the soil that can be readily absorbed and assimilated by growing plants.

Available soil moisture - The portion of water in a soil that can be readily absorbed by plant roots: generally considered to be that water held in the soil up to approximately 15 atmospheres pressure.

Bearing capacity - Capacity of soil (in moist to wet conditions) to support loads such as buildings, people, vehicles, and animals.

Bedrock - The solid rock that underlies soil and regolith or that is exposed at the surface.

Boulders - Stones which are larger than 60 cm in diameter.

Bulk density - The weight of oven dry soil (105 degrees C) divided by its volume at field moisture conditions, expressed in grams per cubic centimeter.

Buried soil - Soil covered by an alluvial, loessial, or other deposit, usually to a depth greater than the thickness of the solum.

Calcareous soil - Soil containing sufficient calcium carbonate (often with magnesium carbonate) to effervesce visibly when treated with hydrochloric acid.

Calcium Carbonate Equivalent - Refers to the percent of carbonates in the soil expressed on the basis of calcium carbonate. Terms used to express the carbonate contents of soils are:

noncalcareous	<1%
weakly calcareous	1-5%
moderately calcareous	6-15%
strongly calcareous	16-25%
v. strongly calcareous	26-40%
extremely calcareous	>40%

Capillary fringe - A zone of essentially saturated soil just above the water table. The size distribution of the pores determines the extent and degree of the capillary fringe.

Carbon-nitrogen ratio (C/N ratio) - The ratio of the weight of organic carbon to the weight of total nitrogen in a soil or in an organic material.

Cation Exchange Capacity (CEC) - A measure of the total amount of exchangeable cations that can be held by a soil. Expressed in milliequivalents per 100g of soil.

Clay - As a soil separate, the mineral soil particles less than 0.002 mm in diameter: usually consisting largely of clay minerals. As a soil textural class, soil materials that contain 40 or more percent clay, less than 45 percent sand and less than 40 percent silt.

Cobbles - Rock fragments 8 to 25 cm in diameter.

Color - Soil colors are compared with a Munsell color chart. The Munsell system specifies the relative degrees of the three simple variables of color: hue, value and chroma. For example: 10YR 6/4 means a hue of 10YR, a value of 6, and a chroma of 4.

Complex (soil) - A mapping unit used in detailed and reconnaissance soil surveys where two or more soil series that are so intimately intermixed in an area that it is impractical to separate them at the scale of mapping used.

Concretions - Hard grains, pellets or nodules from concentration of compounds in the soil that cement soil grains together.

Conductivity, electrical - A physical quantity that measures the readiness with which a medium (irrigation water and soil extracts) transmits electricity. It expresses the concentration of salt in terms of the conductance (reciprocal of the electric resistance in ohms) in millisiemens per cm.

Consistence (soil) - The mutual attraction of the particles in a soil mass, or their resistence to separation or deformation. It is described in terms such as loose, soft, friable, firm, hard, sticky, plastic or cemented.

Consumptive use factor (CU) - The ratio of consumptive use of water by a crop to potential evapotranspiration. and transpiration. An actively growing crop that completely covers the soil over a large area and that has an ample supply of readily available soil water has a consumptive use factor of 1.0.

Consumptive use of water - The sum of the depths of water transpired by the plants and evaporated from the soil surface and from intercepted precipitation. It may be less or greater than potential evapotranspiration.

Contour - An imaginary line connecting points of equal elevation on the surface of the soil.

Cover - This term generally has one of the following meanings:

1. Vegetation or other material providing protection
2. In forestry, low growing shrubs and herbaceous plants under trees (i.e., ground cover vs. tree cover)
3. Any vegetation producing a protective mat on or just above the soil surface.

Creep (soil) - Slow mass movement of soil and soil material down rather steep slopes primarily under the influence of gravity, but aided by saturation with water and by alternate freezing and thawing.

Decile portion - A one-tenth portion. As used in the soil map symbol A7-B3 means that the A soils cover seven tenths and the B soils cover three tenths of the map unit.

Delta - A fluvial or glaciofluvial fan shaped deposit at the mouth of a river that empties into a lake or sea.

Deflocculate - To separate or to break up soil aggregates into individual particles by chemical or physical means or both.

Degradation (of soils) - The changing of a soil to a more highly leached and more highly weathered condition, usually accompanied by morphological changes such as the development of an eluviated light colored (Ae) horizon.

Dispersion - Is rated high, moderate or low depending on how readily the soil structure breaks down or slakes because of excess moisture. A rating of high indicates that soil aggregates slake readily; a rating of low indicates that aggregates are resistant to dispersion and remain clumped together.

Drainage (soil) - (1) The rapidity and extent of the removal of water from the soil by runoff and flow through the soil to underground spaces. (2) As a condition of the soil, it refers to the frequency and duration of periods when the soil is free of saturation.

Drainage in soil reports is described on the basis of actual moisture content in excess of field capacity and length of the saturation period within the plant root zone. The terms are as follows:

Very rapidly drained - Water is removed from the soil very rapidly in relation to supply. Excess water flows downward very rapidly if underlying material is pervious. There may be very rapid subsurface flow during heavy rainfall provided there is a steep gradient. Soils have very low available water storage capacity (usually less than 2.5 cm) within the control section and are usually coarse in texture, or shallow, or both. Water source is precipitation.

Rapidly drained - Water is removed from the soil rapidly in relation to supply. Excess water flows downward if underlying material is pervious. Subsurface flow may occur on steep gradients during heavy rainfall. Soils have low available water storage capacity (2.5-4 cm) within the control section, and are usually coarse in texture, or shallow, or both. Water source is precipitation.

Well drained - Water is removed from the soil readily but not rapidly. Excess water flows downward readily into underlying pervious material or laterally as subsurface flow. Soils have intermediate available water storage capacity (4-5 cm) within the control section, and are generally intermediate in texture and depth. Water source is precipitation. On slopes subsurface flow may occur for short durations but additions are equaled by losses. These soils are usually free of mottles within 100 cm of the surface but may be mottled below this depth. Soil horizons are usually bright colored.

Moderately well drained - Water is removed from the soil somewhat slowly in relation to supply. Excess water is removed somewhat slowly due to low perviousness, shallow water table, lack of gradient, or some combination of these. Soils have intermediate to high water storage capacity (5-6cm) within the control section and are usually medium to fine in texture. Soils are commonly mottled in the 50 to 100 cm depth. Colors are dull brown in the subsoil with stains and mottles.

Imperfectly drained - Water is removed from the soil sufficiently slowly in relation to supply to keep the soil wet for a significant part of the growing season. Excess water moves slowly downward if precipitation is major supply. If subsurface water or groundwater, or both, is the main source, flow rate may vary but the soil remains wet for a significant part of the growing season. Precipitation is the main source if available water storage capacity is high; contribution by subsurface flow or groundwater flow, or both, increases as available water storage capacity decreases. Soils have a wide range in available water supply, texture, and depth, and are gleyed phases of well drained subgroups. These soils generally have mottling below the surface layers and generally have duller colors with depth, generally brownish gray with mottles of yellow and gray.

Poorly drained - Water is removed so slowly in relation to supply that the soil remains wet for a comparatively large part of the time the soil is not frozen. Excess water is evident in the soil for a large part of the time. Subsurface flow or groundwater flow, or both, in addition to precipitation are main water sources; there may also be a perched water table, with precipitation exceeding evapotranspiration. Poorly drained soils have a wide range in available water storage capacity, texture, and depth, and are gleyed subgroups, Gleysols, and Organic soils.

Very poorly drained - Water is removed from the soil so slowly that the water table remains at or on the surface for the greater part of the time the soil is not frozen. Excess water is present in the soil for the greater part of the time. Groundwater flow and subsurface flow are major water sources. Precipitation is less important except where there is a perched water table with precipitation exceeding evapotranspiration. These soils have a wide range in available water storage capacity, texture, and depth, and are either Gleysolic or Organic.

Dryland farming - The practice of crop production in low rainfall areas without irrigation.

Eluvial horizon - A horizon from which material has been removed in solution or in water suspension.

Eolian - Soil material accumulated through wind action.

Erosion - The wearing away of the land surface by detachment and transport of soil and rock material through the action of moving water, wind or other geological processes. The ratings of erosion are:

Erosion 1	slightly eroded - soil with a sufficient amount of the A horizon removed that ordinary tillage will bring up and mix the B horizon or other lower lying horizons with surface soil in the plow layer.
Erosion 2	moderately eroded - soil with all of the A horizon and a part of the B or other lower lying horizons removed. The plow layer consists mainly of the original horizons below the A or below the original plow layer.
Erosion 3	severely eroded - soils have practically all of the original surface soil removed. The plow layer consists mainly of C horizon material, especially on knolls and steep upper slope positions.

Evapotranspiration - The combined loss of water from a given area, and during a specific period of time, by evaporation from the soil surface and transpiration from plants.

Field Moisture Equivalent - The minimum moisture content at which a drop of water placed on a smoothed surface of the soil will not be absorbed immediately by the soil, but will spread out over the surface and give it a shiny appearance.

Flood plain - The land bordering a stream, built up of sediments from overflow of the stream and subject to innundation when the stream is at flood stage.

Fluvial deposits - All sediments past and present, deposited by flowing water, including glaciofluvial deposits.

Frost heave - The raising of the surface caused by ice in the subsoil.

Friable - Soil aggregates that are soft and easily crushed between thumb and forefinger.

Glaciofluvial deposits - Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. These deposits are stratified and may occur in the form of outwash plains, deltas, kames, eskers and kame terraces.

Gleyed soil - An imperfectly or poorly drained soil in which the material has been modified by reduction or alternating reduction and oxidation. These soils have lower chromas or more prominent mottling or both in some horizons than the associated well-drained soil.

Gleysolic - An order of soils developed under wet conditions and permanent or periodic reduction. These soils have low chromas or prominent mottling or both, in some horizons.

Gravel - Rock fragments 2 mm to 7.5 cm in diameter.

Ground Moraine - An unsorted mixture of rocks, boulders, sand, silt and clay deposited by glacial ice. The predominant material is till; most till is thought to have accumulated under the ice by lodgment, but some till has been let down from the upper surface of the ice by ablation. Resorting and modification may have taken place to some extent by wave-action of glacial melt waters. The topography is most commonly in the form of undulating plains with gently sloping hills and enclosed depressions.

Groundwater - Water beneath the soil surface, usually under conditions where the voids are completely filled with water (saturation).

Halophytic vegetation - vegetation that grows naturally in soils having a high content of various salts. It usually has fleshy leaves or thorns and resembles desert vegetation.

Horizon (soil) - A layer in the soil profile approximately parallel to the land surface with more or less well-defined characteristics that have been produced through the operation of soil forming processes.

Horizon boundary - The lower boundary of each horizon is described by indicating its distinctness and form. The distinctness depends on the abruptness of vertical change (thickness). The form refers to the variation of the boundary plane.

Distinctness -
abrupt - less than 2 cm
clear - 2 to 5 cm
gradual - 5 to 15 cm
diffuse - more than 15 cm

Form -
smooth - nearly plain
wavy - pockets are wider than deep
irregular - pockets are deeper than wide
broken - parts of the horizon are unconnected with other parts

Humic layer - A layer of highly decomposed organic soil material containing little fibre.

Hydraulic Conductivity - Refers to the effective flow velocity or discharge velocity in soil at unit hydraulic gradient. It is an approximation of the permeability of the soil and is expressed in cm per hour. The classes are described in general or specific terms as:

High	>15	Very rapid	>50
		Rapid	15-50
Medium	0.5-15	Mod. rapid	5.0-15
		Moderate	1.5-5.0
		Mod. slow	0.5-1.5
Low	<0.5	Slow	0.15-0.5
		Very slow	0.015-0.15
		Extremely slow	<.015

Hydrologic cycle - The conditions through which water naturally passes from the time of precipitation until it is returned to the atmosphere by evaporation and is again ready to be precipitated.

Hydrophyte - Plants growing in water or dependent upon wet or saturated soil conditions for growth.

Illuvial horizon - A soil horizon in which material carried from an overlying layer has been precipitated from solution or deposited from suspension. The layer of accumulation.

Impeded drainage - A condition that hinders the movement of water by gravity through the soils.

Inclusion - Soil type found within a mapping unit that is not extensive enough to be mapped separately or as part of a complex.

Infiltration - The downward entry of water into the soil

Irrigation - The artificial application of water to the soil for the benefit of growing crops.

Irrigation requirement (IR) - Refers to the amount of water exclusive of effective precipitation that is required for crop production.

Lacustrine deposits - Material deposited by or settled out of lake waters and exposed by lowering of the water levels or elevation of the land. These sediments range in texture from sand to clay and are usually varved (layered annual deposits).

Landforms - See Description of Landforms

Landscape - All the natural features such as fields, hills, forest, water, etc., which distinquish one part of the earth's surface from another part.

Leaching - The removal from the soil of materials in solution.

Liquid limit (upper plastic limit) - The water content corresponding to an arbitrary limit between the liquid and plastic states of consistency of a soil. The water content at this boundary is defined as that at which a pat of soil cut by a groove of standard dimensions will flow together for a distance of 1.25 cm under the impact of 25 blows in a standard liquid limit apparatus.

Lineal shrinkage - This is the decrease in one dimension expressed as a percentage of the original dimension of the soil mass when the moisture content is reduced from a stipulated percentage (usually field moisture equivalent) to the shrinkage limit.

Mapping Unit - Any delineated area shown on a soil map that is identified by a symbol. A mapping unit may be a soil unit, a miscellaneous land type, or a soil complex.

Marsh - Periodically flooded or continually wet areas having the surface not deeply submerged. It is covered dominantly with sedges, cattails, rushes or other hydrophytic plants.

Mature soil - A soil having well-developed soil horizons produced by the natural processes of soil formation.

Mesophyte - Plants requiring intermediate moisture conditions and are not very resistant to drought.

Microrelief - Small-scale, local differences in relief including mounds, swales or hollows.

Milliequivalent (me) - One-thousandth of an equivalent. An equivalent is the weight in grams of an ion or compound that combines with or replaces one gram of hydrogen. The atomic or formula weight divided by valence.

Mottles - Irregularly marked spots or streaks, usually yellow or orange but sometimes blue. They are described in order of abundance (few, common, many), size (fine, medium, coarse) and contrast (faint, distinct, prominent). Mottles in soils indicate poor aeration and lack of good drainage.

Organic carbon - Carbon derived from plant and animal residues.

Organic matter - The fraction of the soil which consists of plant and animal residues at various stages of decomposition, cells and tissues of soil organisms and substances synthesized by the soil population. It is determined on soils that have been sieved through a 2.0 mm sieve. It is estimated by multiplying the organic carbon by a factor of 1.72.

Outwash - Sediments "washed out" beyond the glacier by flowing water and laid down in thin beds or strata. Particle size may range from boulders to silt.

Ovendry soil - Soil that has been dried at 105 degrees C until it has reached constant weight.

Parent material - The unaltered or essentially unaltered mineral or organic material from which the soil profile develops by pedogenic processes.

Particle size, soil - The grain size distribution of the whole soil including the coarse fraction. It differs from texture, which refers to the fine earth (less than 2mm) fraction only. In addition, textural classes are usually assigned to specific horizons whereas soil family particle-size classes indicate a composite particle size of a part of the control section that may include several horizons. See Textural Triangle at end of Glossary.

The particle-size classes for family groupings are as follows:

Fragmental Stones, cobbles and gravel, with too little fine earth to fill interstices larger than 1 mm.

Sandy-skeletal Particles coarser than 2 mm occupy 35% or more by volume with enough fine earth to fill interstices larger than 1 mm; the fraction finer than 2 mm is that defined for the sandy particle-size class.

Loamy-skeletal Particles 2 mm-25 cm occupy 35% or more by volume with enough fine earth to fill interstices larger than 1 mm; the fraction finer than 2 mm is that defined for the loamy particle-size class.

Clayey-skeletal Particles 2 mm-25 cm occupy 35% or more by volume with enough fine earth to fill interstices larger than 1 mm; the fraction finer than 2 mm is that defined for the clayey particle-size class.

Sandy The texture of the fine earth includes sands and loamy sands, exclusive of loamy very fine sand and very fine sand textures; particles 2 mm- 25 cm occupy less than 35% by volume.

Loamy The texture of the fine earth includes loamy very fine sand, very fine sand, and finer textures with less than 35% clay; particles 2 mm-25 cm occupy less than 35% by volume.

Coarse-loamy. A loamy particle size that has 15% or more by weight of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has less than 18% clay in the fine earth fraction.

Fine-loamy. A loamy particle size that has 15% or more by weight of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has 18-35% clay in the fine earth fraction.

Coarse-silty. A loamy particle size that has less than 15% of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has less than 18% clay in the fine earth fraction.

Fine-silty. A loamy particle size that has less than 15% of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has 18-35% clay in the fine earth fraction.

Clayey. The fine earth contains 35% or more clay by weight and particles 2mm-25 cm occupy less than 35% by volume.

Fine-clayey. A clayey particle size that has 35-60% clay in the fine earth fraction.

Very-fine-clayey. A clayey particle size that has 60% or more clay in the fine earth fraction.

Ped - An individual soil aggregate such as granule, prism or block formed by natural processes (in contrast with a clod which is formed artificially).

Pedology - Those aspects of soil science involving constitution, distribution, genesis and classification of soils.

Percolation - The downward movement of water through soil; specifically, the downward flow of water in saturated or nearly saturated soil at hydraulic gradients of 1.0 or less.

Permafrost -

1. Perennially frozen material underlying the solum.

2. A perennially frozen soil horizon.

Permafrost table - The upper boundary of permafrost, usually coincident with the lower limit of seasonal thaw (active layer).

Permeability - The ease with which water and air pass through the soil to all parts of the profile. See hydraulic conductivity.

pH - The intensity of acidity and alkalinity, expressed as the negative logarithm of the hydrogen ion concentration. A pH of 7 is neutral, lower values indicate acidity and higher values alkalinity (see Reaction, soil).

Phase, soil - A soil phase is used to characterize soil and landscape properties that are not used as criteria in soil taxonomy. The major phase differentiae are: slope, erosion, deposition, stoniness, texture, salinity, and calcareousness.

Plastic Limit - The water content corresponding to an arbitrary limit between the plastic and the semisolid states of consistency of a soil.

Plasticity Index - The numerical difference between the liquid and the plastic limit. The plasticity index gives the range of moisture contents within which a soil exhibits plastic properties.

Potential evapotranspiration (PE) - The maximum quantity of water capable of being lost as water vapor, in a given climate, by a continuous stretch of vegetation covering the whole ground and well supplied with water.

Profile, soil - A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil - The acidity or alkalinity of a soil. Soil reaction classes are characterized as follows:

extremely acid	pH <4.5
very strongly acid	4.5 to 5.0
strongly acid	5.1 to 5.5
medium acid	5.6 to 6.0
slightly acid	6.1 to 6.5
neutral	6.6 to 7.3
mildly alkaline	7.4 to 7.8
mod. alkaline	7.9 to 8.4
strongly alkaline	8.5 to 9.0
very strongly alkaline	>9.0

Regolith - The unconsolidated mantle of weathered rock and soil material on the earth's surface.

Relief - The elevation of inequalities of the land surface when considered collectively.

Runoff - The portion of the total precipitation on an area that flows away through stream channels. Surface runoff does not enter the soil. Groundwater runoff or seepage flow from groundwater enters the soil before reaching the stream.

Saline Soil - A nonalkali soil containing soluble salts in such quantities that they interfere with the growth of most crop plants. The conductivity of the saturation extract is greater than 4 millisiemens/cm (ms/cm), the exchangeable-sodium percentage is less than 15, and the pH is usually less than 8.5. Approximate limits of salinity classes are:

non-saline	0 to 4 ms/cm
weakly saline	4 to 8 mS/cm
mod. saline	8 to 15 ms/cm
strongly saline	>15 ms/cm

Salinization - The process of accumulation of salts in the soil.

Salt-Affected Soil - Soil that has been adversely modified for the growth of most crop plants by the presence of certain types of exchangeable ions or of soluble salts. It includes soils having an excess of salts, or an excess of exchangeable sodium or both.

Sand - A soil particle between 0.05 and 2.0 mm in diameter. The textural class name for any soil containing 85 percent or more of sand and not more than 10 percent of clay.

Saturation Percentage - The moisture percentage of a saturated soil paste, expressed on an oven dry weight basis.

Seepage -

1. The escape of water downward through the soil.

2. The emergence of water from the soil along an extensive line of surface in contrast to a spring where water emerges from a local spot.

Series, soil - A category in the Canadian System of Soil Classification. It consists of soils that have soil horizons similar in their differentiating characteristics and arrangement in the profile, except for surface texture and are formed from a particular type of parent material.

Shrinkage limit - This is the moisture content at which an equilibrium condition of volume change is reached and further reduction in moisture content will not cause a decrease in the volume of the soil mass.

Shrinkage ratio - This is the ratio between the volume change and a corresponding change in moisture content. It equals the apparent specific gravity of the dried soil.

Silt - (a) Individual mineral particles of soil that range in diameter between 0.05 to .002 mm. (b) Soil of the textural class silt contains greater than 80 percent silt and less than 12 percent clay.

Slickenside - Smoothed surfaces along planes of weakness resulting from the movement of one mass of soil against another in soils dominated by swelling clays.

Sodium-Adsorption Ratio (S.A.R.) - A ratio for soil extracts and irrigation waters used to express the relative activity of sodium ions in exchange reactions with other cations in the soil SAR = $Na/((Ca+Mg)/2)^{1/2}$ where the cation concentrations are expressed as milliequivalents per litre.

Soil - The unconsolidated mineral material on the immediate surface of the earth that serves as a natural medium for the growth of land plants. Soil has been subjected to and influenced by genetic and environmental factors of: parent material, climate (including moisture and temperature effects), macro- and microorganisms, and topography, all acting over a period of time.

Solum - The upper horizons of a soil above the parent material and in which the processes of soil formation are active. It usually comprises the A and B horizons.

Stones - Rock fragments greater than 25 cm in diameter.

Stoniness - The percentage of land surface occupied by stones. The classes of stoniness are defined as follows:

Stones 0. Nonstony -- Land having less than 0.01% of surface occupied by stones.

Stones 1. Slightly stony -- Land having 0.01-0.1% of surface occupied by stones. Stones 15-30 cm in diameter, 10-30 m apart. The stones offer only slight to no hindrance to cultivation.

Stones 2. Moderately stony -- Land having 0.1-3% of surface occupied by stones. Stones 15-30 cm in diameter, 2-10 m apart. Stones cause some interference with cultivation.

Stones 3. Very stony -- Land having 3-15% of surface occupied by stones. Stones 15-30 cm in diameter, 1-2 m apart. There are sufficient stones to constitute a serious handicap to cultivation.

Stones 4. Exceedingly stony -- Land having 15-50% of surface occupied by stones. Stones 15-30 cm in diameter, 0.7-1.5 m apart. There are sufficient stones to prevent cultivation until considerable clearing has been done.

Stones 5. Excessively stony -- Land having more than 50% of surface occupied by stones. Stones 15-30 cm in diameter, less than 0.7 m apart. The land is too stony to permit cultivation.

Storage Capacity - Refers to the maximum amount of readily available water that can be stored within the rooting zone of a crop in a given soil. For practical irrigation purposes, 50 percent of the total soil water between field capacity and wilting point may be considered as readily available.

Stratified materials - Unconsolidated sand, silt and clay arranged in strata or layers. In stratified materials, a bed is a unit layer distinctly separable from other layers and is one or more cm thick but a lamina is a similar layer less than 1 cm thick.

Structure - The combination or arrangement of primary soil particles into aggregates of secondary soil particles, units or peds, which are separated from each other by surfaces of weakness. Structure is expressed in terms of grade, size class and shape type. Grade refers to the distinctness of aggregate development, and is described as structureless, weak, moderate or strong. Structureless refers to the absence of observable aggregation of definite orderly arrangement; the term amorphous is used if soil is massive or coherent, single-grained if noncoherent. The weak to strong aggregates vary in size and are described by class as fine, medium, coarse, and very coarse depending on the shape types. The shape types refers to the dominant configuration of the aggregates and the way they are accommodated. The general shape types are plate-like, block-like and prism-like. The terms are:

Platy - Having thin, plate-like aggregates with faces mostly horizontal

Prismatic - Having prism-like aggregates with tops and edges, appear plane, level and somewhat angular.

Columnar - Having prism-like aggregates with vertical edges near the top of columns, not sharp.

Granular - Having block-like aggregates that appear as spheroids or polyhedrons having plane or curved surfaces which have slight or no accommodation to the faces of the surrounding peds.

Blocky - Having block-like aggregates with sharp, angular corners

Subangular blocky - Having block-like aggregates with rounded and flattened faces and rounded corners.

By convention an aggregate is described in the order of grade, class and type, e.g. strong, medium, blocky. In the parent material of soils the material with structural shapes may be designated as pseudo-blocky, pseudo-platy, etc.

Soil Survey - The systematic examination, description, classification, and mapping of soil in an area.

Sulfate Hazard - Refers to the relative degree of attack on concrete by soil and water containing various amounts of sulfate ions. It is estimated from electrolyte measurements and salt analysis on selected profiles and soil samples, and by visual examination of free gypsum within the profile during the course of soil investigation.

Swamp - See Description of Landforms

Texture, soil - The relative proportions of the fine earth (less than 2 mm.) fraction of a soil. Textural classes are usually assigned to specific horizons whereas family particle size classes indicate a composite particle size of a portion of the control section that may include several horizons. See Texture Triangle at end of Glossary.

The size range of the constituent primary particles are as follows:

	Diameter (mm)
Very coarse sand	2.0-1.0
Coarse sand	1.0-0.5
Medium sand	0.5-0.25
Fine sand	0.25-0.10
Very fine sand	0.10-0.05
Silt	0.05-0.002
Clay	< 0.002
Fine clay	< 0.0002

Till, glacial - Unstratified glacial deposits consisting of clay, sand, gravel, and boulders intermingled in any proportion.

Tilth - The physical condition of soil as related to its ease of tillage, fitness as a seedbed, and its impedance to seedling emergency and root penetration.

Topography - Refers to the percent slope and the pattern or frequency of slopes in different directions. A set of 10 slope classes are used to denote the dominant but not necessarily most abundant slopes within a mapping unit.

Slope Class	Slope Name	Percent slope	Approx. degrees
1	level	0-0.5	0
2	nearly level	.5-2.5	.3-1.5
3	very gentle	2-5	1-3
4	gentle	6-9	3.5-5
5	moderate	10-15	6-8.5
6	strong	16-30	9-17
7	very strong	31-45	17-24
8	extreme	46-70	25-35
9	steep	71-100	35-45
10	very steep	>100	>45

Underground runoff - (or seepage)-Water flowing towards stream channels after infiltration into the ground.

Unified Soil Classification System (engineering) - A classification system based on the identification of soils according to their particle size, gradation, plasticity index and liquid limit.

Urban Land - Areas so altered or obstructed by urban works or structures that identification of soils is not feasible.

Variant, soil - A soil whose properties are believed to be sufficiently different from other known soils to justify a new series name, but comprising such a limited geographic area that creation of a new series is not justified.

Varve - A distinct band representing the annual deposit in sedimentary materials regardless of origin and usually consisting of two layers, one thick light colored layer of silt and fine sand laid down in the spring and summer, and the other a thin, dark colored layer of clay laid down in the fall and winter.

Water balance, soil - Is the daily amount of readily available water retained by the soil. The daily soil-water balance is decreased by the amount that the daily consumptive use exceeds the daily rainfall. When daily rainfall exceeds the consumptive use, the daily balance increases by the amount of the difference unless the soil-water balance is at storage capacity, in which case the excess is assumed to be lost by runoff or deep percolation.

Water table - (groundwater surface; free water surface; groundwater elevation) Elevation at which the pressure in the water is zero with respect to the atmospheric pressure.

Water-holding capacity - The ability of a soil to hold water against the force of gravity in a freely drained soil.

Weathering - The physical and chemical disintegration, alteration and decomposition of rocks and minerals at or near the earth's surface by atmospheric agents.

Xerophyte - Plants capable of surviving extended periods of soil drought.

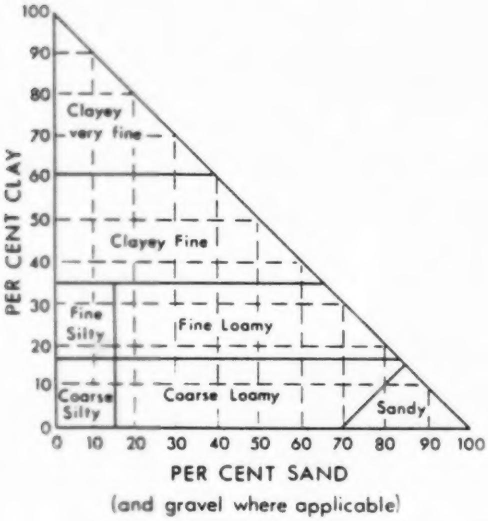
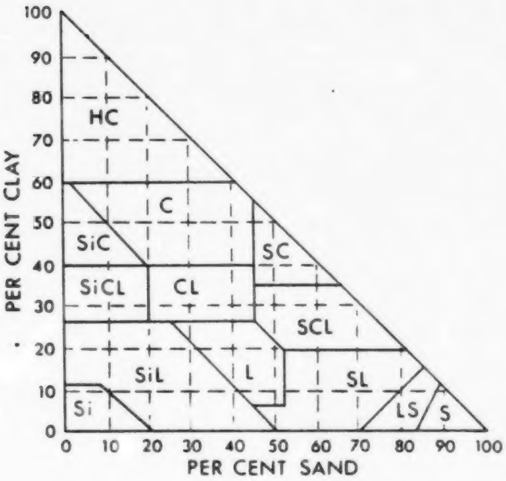

PER CENT CLAY
100
90
80
70
60
50
40
30
20
10
0
Clayey very fine
Clayey Fine
Fine Silty
Fine Loamy
Coarse Silty
Coarse Loamy
Sandy
0 10 20 30 40 50 60 70 80 90 100
PER CENT SAND
(and gravel where applicable)

Figure 6: Family particle-size classes.


PER CENT CLAY
100
90
80
70
60
50
40
30
20
10
0
HC
C
SiC
SC
SiCL
CL
SCL
SiL
L
SL
Si
LS
S
0 10 20 30 40 50 60 70 80 90 100
PER CENT SAND

Texture Group	Class Symbol	Class Name
Coarse	S	sand
	LS	loamy sand
Moderately coarse	SL	sandy loam
	LVFS	loamy very fine sand
Medium	Si	silt
	SiL	silt loam
	L	loam
	VFSL	very fine sandy loam
Moderately fine	SCL	sandy clay loam
	CL	clay loam
	SiCL	silty clay loam
Fine	SC	sandy clay
	C	clay
	SiC	silty clay
Very fine	HC	heavy clay

Figure 7: Soil Textural Classes.

Appendix D

SOIL HORIZON DESIGNATIONS

ORGANIC HORIZONS

Organic horizons are found in Organic soils, and commonly at the surface of mineral soils. They may occur at any depth beneath the surface in buried soils, or overlying geologic deposits. They contain more than 17% organic carbon (approximately 30% organic matter) by weight. Two groups of these horizons are recognized, O horizons and the L, F, and H horizons.

O This is an organic horizon developed mainly from mosses, rushes, and woody materials.

Of The fibric horizon is the least decomposed of all the organic soil materials. It has large amounts of well-preserved fiber that are readily identifiable as to botanical origin. A fibric horizon has 40% or more of rubbed fiber by volume and a pyrophosphate index of 5 or more. If the rubbed fiber volume is 75% or more, the pyrophosphate criterion does not apply.

Om The mesic horizon is the intermediate stage of decompostion with intermediate amounts of fiber, bulk density and water-holding capacity. The material is partly altered both physically and biochemically. A mesic horizon is one that fails to meet the requirements of fibric or humic.

Oh The humic horizon is the most highly decomposed of the organic soil materials. It has the least amount of fiber, the highest bulk density, and the lowest saturated water-holding capacity. It is very stable and changes very little physically or chemically with time unless it is drained. The humic horizon has less than 10% rubbed fiber by volume and a pyrophosphate index of 3 or less.

LFH These organic horizons developed primarily from leaves, twigs, woody materials and a minor component of mosses under imperfectly to well drained forest conditions.

L This is an organic horizon characterized by an accumulation of organic matter in which the original structures are easily discernible.

F This is an organic horizon characterized by an accumulation of partly decomposed organic matter. The original structures in part are difficult to recognize. The horizon may be partly comminuted by soil fauna as in moder, or it may be a partly decomposed mat permeated by fungal hyphae as in mor.

H This is an organic horizon

characterized by an accumulation of decomposed organic matter in which the original structures are indiscernible. This material differs from the F horizon by its greater humification chiefly through the action of organisms. It is frequently intermixed with mineral grains, especially near the junction with the mineral horizon.

MASTER MINERAL HORIZONS

Mineral horizons are those that contain less than 30% organic matter by weight as specified for organic horizons.

A This is a mineral horizon or horizons formed at or near the surface in the zone of leaching or removal of materials in solution and suspension or of maximum in situ accumulation of organic matter, or both. Included are:

1. horizons in which organic matter has accumulated as a result of biological activity (Ah);
2. horizons that have been eluviated of clay, iron, aluminum, or organic matter, or all of them (Ae);
3. horizons having characteristics of 1) and 2) above but transitional to underlying B or C (AB or A and B);
4. horizons markedly disturbed by cultivation or pasture (Ap).

B This is a mineral horizon or horizons characterized by one or more of the following:

1. an enrichment in silicate clay, iron, aluminum, or humus, alone or in combination (Bt,Bf,Bfh,Bhf, and Bh);
2. a prismatic or columnar structure that exhibits pronounced coatings or stainings and significant amount of exchangeable Na (Bn);
3. an alteration by hydrolysis, reduction, or oxidation to give a change in color or structure from horizons above or below, or both, and does not meet the requirements of 1) and 2) above (Bm,Bg).

C This is a mineral horizon or horizons comparatively unaffected by the pedogenic processes operative in A and B, excepting (i) the process of gleying, and (ii) the accumulation of calcium and magnesium carbonates and more soluble salts (Cca,Csa,Cg, and C). Marl and diatomaceous earth are considered to be C horizons.

R This is consolidated bedrock that is too hard to break with the hands or to dig with a spade when moist and that does not meet the requirement of a C horizon. The boundary between the R layer and overlying unconsolidated material is called a lithic contact.

W This is a layer of water in Gleysolic, Organic, or Cryosolic soils. It is called a hydric layer in Organic soils.

LOWER-CASE SUFFIXES

b Buried soil horizon.

c A cemented (irreversible) pedogenic horizon. The ortstein of a Podzol, and a layer cemented by calcium carbonate and a duripan are examples.

ca A horizon with secondary carbonate enrichment where the concentration of lime exceeds that present in the unenriched parent material. It is more than 10 cm thick, and if it has a CaCO3 equivalent of less than 15 percent it should have at least 5 percent more CaCO3 equivalent than the parent material (IC). If it has more than 15 percent CaCO3 equivalent it should have 1/3 more CaCO3 equivalent than the IC. If no IC is present, this horizon is more than 10 cm thick and contains more than 5 percent by volume of secondary carbonates in concretions or soft, powdery forms.

cc Cemented (irreversible) pedogenic concretions.

e A horizon characterized by the eluviation of clay, iron, aluminum, or organic matter alone or in combination. When dry, it is usually higher in color value by 1 or more units than an underlying B horizon. It is used with A (Ae).

f A horizon enriched with amorphous material, principally Al and Fe combined with organic matter. It usually has a hue of 7.5YR or redder or its hue is 10YR near the upper boundary and becomes yellower with depth. When moist, the chroma is higher than 3 or the value is 3 or less. It contains 0.6% or more pyrophosphate-extractable Al+Fe in textures finer than sand and 0.4% or more in sands (coarse sand, sand, fine sand, and very fine sand). The ratio of pyrophosphate-extractable Al+Fe to clay (less than 0.002mm) is more than 0.05 and organic C exceeds 0.5%. Pyrophosphate-extractable Fe is at least 0.3%, or the ratio of organic C to pyrophosphate-extractable Fe is less than 20, or both are true. It is used with B alone (Bf), with B and h (Bhf), with B and g (Bfg), and with other suffixes. The criteria for "f" do not apply to Bgf horizons. The following horizons are differentiated on the basis of organic carbon content: Bf - 0.5% to 5% organic carbon. Bhf- more than 5% organic carbon.

g A horizon characterized by gray colors, or prominent mottling, or both, indicative of permanent or periodic intense reduction. Chromas of the matrix are generally 1 or less. It is used with A and e (Aeg); with B alone (Bg); with B and f (Bfg); with B, h, and f (Bhfg); with B and t (Btg); with C alone (Cg); with C and k (Ckg); and several others. In some reddish parent materials, matrix colors of reddish hues and high chromas may persist despite long periods of reduction. In these soils, horizons are designated as g if there is gray mottling or if there is marked bleaching on ped faces or along cracks.

Aeg This horizon must meet the definitions of A,e, and g.

Bg These horizons are analogous to Bm horizons but they have colors indicative of poor drainage and periodic reduction. They include horizons occurring between A and C horizons in which the main features are (i) colors of low chroma, that is: chromas of 1 or less, without mottles on ped surfaces or in the matrix if peds are lacking; or chromas of 2 or less in hues of 10YR or redder, on

	ped surfaces or in the matrix if peds are lacking, accompanied by more prominent mottles than those in the C horizon; or hues bluer than 10Y, with or without mottles on ped surfaces or in the matrix if peds are lacking. (ii) colors indicated in (i) and a change in structure from that of the C horizons. (iii) color indicated in (i) and illuviation of clay too slight to meet the requirements of Bt; or accumulation or iron oxide too slight to meet the limits of Bgf. (iv) colors indicated in (i) and removal of carbonates. Bg horizons occur in some Orthic Humic Gleysols and some Orthic Gleysols.
Bfg,	Bhfg, Btg, and others. When used in any of these combinations the limits set for f, hf, t, and others must be met.
Bgf	The dithionite-extractable Fe of this horizon exceeds that of the IC by 1% or more. Pyrophosphate-extractable Al + Fe is less than the minimum limit specified for 'f' horizons. This horizon occurs in Fera Gleysols and Fera Humic Gleysols, and possibly below the Bfg of gleyed Podzols. It is distinguished from the Bfg of gleyed Podzols on the basis of the extractability of the Fe and Al. The Fe in the Bgf horizon is thought to have accumulated as a result of the oxidation of ferrous iron. The iron oxide formed is not associated intimately with organic matter or with Al, and it is sometimes crystalline. The Bgf horizons are usually prominently mottled, with more than half of the soil material occurring as mottles of high chroma.
Cg,	Ckg, Ccag, Csg, Csag. When g is used with C alone, or with C and one of the lower-case suffixes k, ca, s, or sa, it must meet the definiton for C and for the particular suffix.
h	A horizon enriched with organic matter. It is used with A alone (Ah); or with A and e (Ahe); or with B alone (Bh); or with B and f (Bhf).
Ah	A horizon enriched with organic matter that either has a color value at least one unit lower than the underlying horizon or contains 0.5% more organic carbon than the IC, or both. It contains less than 17% organic carbon by weight.
Ahe	An Ah horizon that has undergone eluviation as evidenced, under natural conditions, by streaks and splotches of differing shades of gray and often by platy structure. It may be overlain by a darker-colored Ah and underlain by a lighter-colored Ae.
Bh	This horizon contains more than 1% organic carbon, less than 0.3% pyrophosphate-extractable Fe, and has a ratio of organic carbon to pyrophosphate-extractable Fe of 20 or more. Generally the color value

and chroma are less than 3 when moist.

Bhf Defined under 'f'.

j Used as a modifier of the suffixes e, f, g, n, and t to denote an expression of, but failure to meet, the specified limits of the suffix it modifies. It must be placed to the right and adjacent to the suffix it modifies. For example Bfgj means a Bf horizon with weak expression of gleying; Bfjgj means a B horizon with weak expression of both 'f' and 'g' features.

Aej It denotes an eluvial horizon that is thin, discontinuous or slightly discernible.

Btj It is a horizon with some illuviation of clay, but not enough to meet the limits of Bt.

Btgj, Bmgj. Horizons that are mottled but do not meet the criteria of Bg.

Bfj It is a horizon with some accumulation of pyrophosphate-extractable Al and Fe but not enough to meet the limits of Bf.

Bntj or Bnj. Horizons in which development of solonetzic B properties is evident but insufficient to meet the limits for Bn or Bnt.

k Denotes the presence of carbonate, as indicated by visible effervescence when dilute HCl is added. Most often it is used with B and m (Bmk) or C (Ck), and occasionally with Ah or Ap (Ahk, Apk), or organic horizons (Ofk, Omk).

m A horizon slightly altered by hydrolysis, oxidation, or solution, or all three, to give a change in color or structure, or both. It has:

1. Evidence of alteration in one of the following forms:
    a) Higher chromas and redder hues than the underlying horizons.
    b) Removal of carbonates, either partially (Bmk) or completely (Bm).
2. Illuviation, if evident, too slight to meet the requirements of a Bt or a podzolic B.
3. Some weatherable minerals.
4. No cementation or induration and lacks a brittle consistence when moist. This suffix can be used as Bm, Bmgj, Bmk, and Bms.

n A horizon in which the ratio of exchangeable Ca to exchangeable Na is 10 or less. It must also have the following distinctive morphological characteristics: prismatic or columnar structure, dark coatings on ped surfaces, and hard to very hard consistence when dry. It is used with B, as Bn or Bnt.

p A horizon disturbed by man's activities, such as cultivation, logging, habitation, etc. It is used with A and O.

s A horizon with salts, including gypsum, which may be detected as crystals or veins, as surface crusts of salt crystals, by depressed crop growth, or by the presence of salt-tolerant plants. It is commonly used with C and k (Csk), but can be used with any horizon or combination of horizon and lowercase suffix.

sa A horizon with secondary enrichment of salts more soluble than calcium and magnesium carbonates, in which the concentration of salts exceeds that present in the unenriched parent material. The horizon is 10 cm or more thick. The conductivity of the saturation extract must be at least 4 ms/cm and must exceed that of the C horizon by at least one-third.

t An illuvial horizon enriched with silicate clay. It is used with B alone (Bt), with B and g (Btg), with B and n (Bnt), etc.

Bt A Bt horizon is one that contains illuvial layer-lattice clays. It forms below an eluvial horizon, but may occur at the surface of a soil that has been partially truncated. It usually has a higher ratio of fine clay to total clay than IC. It has the following properties:

1. If any part of an eluvial horizon remains and there is no lithologic discontinuity between it and the Bt horizon, the Bt horizon contains more total and fine clay than the eluvial horizons, as follows:
   - a) If any part of the eluvial horizon has less than 15% total clay in the fine earth fraction (2mm) the Bt horizon must contain at least 3% more clay, e.g.,Ae 10% clay-Bt minimum 13% clay.
   - b) If the eluvial horizon has more than 15% and less than 40% total clay in the fine earth fraction, the ratio of the clay in the Bt horizon to that in the eluvial horizon must be 1.2 or more, e.g., 20% clay increase in the Bt over Ae.
   - c) If the eluvial horizon has more than 40% total clay in the fine earth fraction, the Bt horizon must contain at least 8% more clay than the eluvial horizon, e.g. Ae 50% clay; Bt at least 58% clay.
2. A Bt horizon must be at least 5 cm thick. In some sandy soils where clay accumulation occurs in the lamellae, the total thickness of the lamellae should be more than 10 cm in the upper 150 cm of the profile.
3. In massive soils the Bt horizon should have oriented clays in some pores and also as bridges between the sand grains.
4. If peds are present, a Bt horizon shows clay skins on some of the vertical and horizontal ped surfaces and in the fine pores, or shows oriented clays in 1% or more of the cross section, as viewed in thin section.

5. If a soil shows a lithologic discontinuity between the eluvial horizon and the Bt horizon, or if only a plow layer overlies the Bt horizon, the Bt horizon need show only clay skins in some part, either in some fine pores or on some vertical and horizontal ped surfaces. Thin sections should show that some part of the horizon has about 1% or more of oriented clay bodies.

Btj, Btj, and Btg are defined under j and g.

u A horizon that is markedly disrupted by physical or faunal processes other than cryoturbation. Evidence of marked disruption such as the inclusion of material from other horizons, absence of the horizon, etc. must be evident in at least half of the cross section of the pedon. Such turbation can result from blowdown of trees, mass movement of soil on slopes, and burrowing animals. It can be used with any horizon or subhorizon with the exception of A or B alone; e.g. Aeu, Bfu, BCu.

x A horizon of fragipan character. A fragipan is a loamy subsurface horizon of high bulk density and very low organic matter content. When dry, it has a hard consistence and seems to be cemented. When moist, it has moderate to weak brittleness. It frequently has bleached fracture planes and is overlain by a friable B horizon. Air dry clods of fragic horizons slake in water.

y A horizon affected by cryoturbation as manifested by disrupted and broken horizons,, incorporation of materials from other horizons and mechanical sorting in at least half of the cross section of the pedon. It is used with A, B, and C alone or in combination with other subscripts, e.g. Ahy, Ahgy, Bmy, Cy, Cgy, Cygj, etc.

z A frozen layer. It may be used with any horizon or layer, e.g. Ohz, Bmz, Cz, Wz.

Appendix E

DESCRIPTION OF LANDFORMS

E.1 GENETIC MATERIALS

Unconsolidated mineral component

The unconsolidated mineral component consists of clastic sediments that may or may not be stratified, but whose particles are not cemented together. They are essentially of glacial or post-glacial origin but include poorly consolidated and weathered bedrock.

Anthropogenic - Man-made or man-modified materials, including those associated with mineral exploitation and waste disposal.

Colluvial - Massive to moderately well stratified, nonsorted to poorly sorted sediments with any range of particle sizes from clay to boulders and blocks that have reached their present position by direct, gravity-induced movement.

They are restricted to products of mass-wasting whereby the debris is not carried by wind, water, or ice (excepting snow avalanches).

Eolian - Sediment, generally consisting of medium to fine sand and coarse silt particle sizes, that is well sorted, poorly compacted, and may show internal structures such as cross bedding or ripple laminae, or may be massive. Individual grains may be rounded and show signs of frosting.

These materials have been transported and deposited by wind action.

Fluvial - Sediment generally consisting of gravel and sand with a minor fraction of silt and clay. The gravels are typically rounded and contain interstitial sand. Fluvial sediments are commonly moderately to well sorted and display stratification, but massive, nonsorted fluvial gravels do occur. These materials have been transported and deposited by streams and rivers. Finer textured Fluvial deposits of modern rivers are termed Alluvium.

Lacustrine - Sediment generally consisting of either stratified fine sand, silt, and clay deposited on the lake bed; or moderately well sorted and stratified sand and coarser materials that are beach and other nearshore sediments transported and deposited by wave action.

These are materials that either have settled from suspension in bodies of standing fresh water or have accumulated at their margins through wave action.

Marine - Unconsolidated deposits of clay, silt, sand, or gravel that are well to moderately well sorted and well stratified to moderately stratified (in some places containing shells). They have settled from suspension in salt or brackish water bodies or have accumulated at their margins through shoreline processes such as wave action and longshore drift.

Morainal - Sediment generally consisting of well compacted material that is nonstratified and contains a heterogeneous mixture of particle sizes, often in a mixture of sand, silt, and clay that has been transported beneath, beside, on, within and in front of a glacier and not modified by any intermediate agent.

Saprolite - Rock containing a high proportion of residual silts and clays formed by alteration, chiefly by chemical weathering.

The rock remains in a coherent state, interstitial grain relationships are undisturbed and no downhill movement due to gravity has occurred.

Undifferentiated - A layered sequence of more than three types of genetic material outcropping on a steep erosional escarpment.

Volcanic - Unconsolidated pyroclastic sediments. These include volcanic dust, ash, cinders, and pumice.

Qualifying Descriptors

These have been introduced to qualify the genetic materials and to supply additional information about the mode of formation or depositional environment.

Glacial - Used to qualify nonglacial genetic materials or process modifiers where there is direct evidence that glacier ice exerted a strong but secondary or indirect control upon the mode of origin of the materials or mode of operation of the process. The use of this qualifying descriptor implies that glacier ice was close to the site of the deposition of a material or the site of operation of a process.

Glaciofluvial - Fluvial materials showing clear evidence of having been deposited either directly in front of or in contact with glacier ice.

Glaciolacustrine - Lacustrine materials deposited in contact with glacial ice.

Glaciomarine - Materials of glacial origin laid down in a marine environment, as a result of settling from melting, floating ice and ice shelves.

Organic component

The organic component consists of peat deposits containing >30% organic matter by weight that may be as thin as 10 cm if they overlie bedrock but are otherwise greater than 40 cm and generally greater than 60 cm thick. The classes and their definitions follow.

B	Bog
N	Fen
S	Swamp

Bog - A bog is a peat-covered or peat-filled area, generally with a high water table. Since the surface of the peatland is slightly elevated, bogs are either unaffected or partly affected by nutrient-rich groundwaters from the surrounding mineral soils. The groundwater is generally acidic and low in nutrients (ombrotrophic). The dominant peat materials are sphagnum and forest peat, underlain, at times, by fen peat.

Fen - A fen is a peat-covered or peat-filled area with a high water table, which is usually at the surface. The dominant materials are shallow to deep, well to moderately decomposed fen peat. The waters are mainly rich in nutrients (minerotrophic) and are derived from mineral soils. The peat materials are therefore higher in both nutrients and pH than the peats associated with bogs.

Swamp - A swamp is a peat-covered or peat-filled area. The peat surface is level or slightly concave in cross section. The water table is frequently at or above the peat surface. There is strong water movement from margins or other mineral sources. The microrelief is hummocky, with many pools present. The waters are neutral or slightly acid. The dominant peat materials are shallow to deep mesic to humic forest and fen peat.

E.2 GENETIC MATERIAL MODIFIERS

Material modifiers are used to qualify unconsolidated mineral and organic deposits. Particle-size classes serve to indicate the size, roundness, and sorting of unconsolidated mineral deposits. Fiber classes indicate the degree of decomposition and fiber size of organic materials.

Particle size classes for unconsolidated mineral materials

Blocky: An accumulation of angular particles greater than 256 mm in size.

Bouldery: An accumulation of rounded particles greater than 256 mm in size.

Clayey: An accumulation of particles where the fine earth fraction contains 35% or more clay (<0.002 mm) by weight and particles greater than 2 mm are less than 35% by volume.

Cobbly: An accumulation of rounded particles having a diameter of 64-256 mm.

Gravelly: An accumulation of rounded particles ranging in size from pebbles to boulders.

Loamy: An accumulation of particles of which fine earth fraction contains 35% or less clay (<0.002 mm) by weight and particles greater than 2 mm are less than 35% by volume.

Pebbly: An accumulation of rounded particles having a diameter of 2-64 mm.

Rubbly: An accumulation of angular fragments having a diameter of 2-256 mm.

Sandy: An accumulation of particles of which the fine earth fraction contains more than 70% by weight of fine sand or coarser particles. Particles greater than 2 mm occupy less than 35% by volume.

Silty: An accumulation of particles of which the fine earth fraction contains less than 15% of fine sand or coarser particles and has less than 35% clay. Particles greater than 2 mm occupy less than 35% by volume.

Fiber classes for organic materials

The amount of fiber and its durability are important characterizing features of organic deposits in that they reflect on the degree of decomposition of the material. The prevalence of woody materials in peats is also of prime importance.

Fibric: The least decomposed of all organic materials; there is a large amount of well-preserved fiber that is readily identifiable as to botanical origin. Fibers retain their character upon rubbing.

Mesic: Organic material in an intermediate stage of decompostion; intermediate amounts of fiber are present that can be identified as to their botanical origin.

Humic: Highly decomposed organic material; small amounts of fiber are present that can be identified as to their botanical origin. Fibers can be easily destroyed by rubbing.

Woody: Organic material containing more than 50% of woody fibers.

E.3 SURFACE EXPRESSION

The surface expression of genetic materials is their form (assemblage of slopes) and pattern of forms. Form as applied to unconsolidated deposits refers specifically to the product of the initial mode of origin of the materials. When applied to consolidated materials, form refers to the product of their modification by geological processes. Surface expression also indicates the manner in which unconsolidated genetic materials relate to the underlying unit.

Consolidated and Unconsolidated mineral surface classes

Apron - A relatively gentle slope at the foot of a steeper slope and formed by materials from the steeper, upper slope.

Blanket - A mantle of unconsolidated materials thick enough to mask minor irregularities in the underlying unit but still conforming to the general underlying topography.

Fan - A fan-shaped form similar to the segment of a cone and having a perceptible gradient from the apex to the toe.

Hummocky - A very complex sequence of slopes extending from somewhat rounded depressions or kettles of various sizes to irregular to conical knolls or knobs. There is a general lack of concordance between knolls or depressions. Slopes are generally 9-70% (5-35 degrees).

Inclined - A sloping, unidirectional surface with a generally constant slope not broken by marked irregularities. Slopes are 2-70% (1-35 degrees). The form of inclined slopes is not related to the initial mode of origin of the underlying material.

Level - A flat or very gently sloping, unidirectional surface with a generally constant slope not broken by marked elevations and depressions. Slopes are generally less than 2% (1 degree).

Rolling - A very regular sequence of moderate slopes extending from rounded, sometimes confined concave depressions to broad, rounded convexities producing a wavelake pattern of moderate relief. Slope length is often 1.6 km or greater and gradients are greater than 5% (3 degrees).

Ridged - A long, narrow elevation of the surface, usually sharp crested with steep sides. The ridges may be parallel, subparallel, or intersecting.

Steep - Erosional slopes, greater than 70% (35 degrees), on both consolidated and unconsolidated materials. The form of a steep erosional slope on unconsolidated materials is not related to the initial mode of origin of the underlying material.

Terraced - Scarp face and the horizontal or gently inclined surface (tread) above it.

Undulating - A very regular sequence of gentle slopes that extends from rounded, sometimes confined concavities to broad rounded convexities producing a wavelike pattern of low local relief. Slope length is generally less than 0.8 km and the dominant gradient of slopes is 2-5% (1-3 degrees).

Veneer - Unconsolidated materials too thin to mask the minor irregularities of the underlying unit surface. A veneer will range from 10 cm to 1 m in thickness and will possess no form typical of the material's genesis.

Organic surface classes

Blanket - A mantle of organic materials that is thick enough to mask minor irregularities in the underlying unit but still conforms to the general underlying topography.

Bowl - A bog or fen occupying concave-shaped depressions.

Domed - A bog with an elevated, convex, central area much higher than the margin. Domes may be abrupt (with or without a frozen core) or gently sloping or have a stepped surface.

Floating - A level organic surface associated with a pond or lake and not anchored to the lake bottom.

Horizontal - A flat peat surface not broken by marked elevations and depressions.

Plateau - A bog with an elevated, flat, central area only slightly higher than the margin.

Ribbed - A pattern of parallel or reticulate low ridges associated with fens.

Sloping - A peat surface with a generally constant slope not broken by marked irregularities.

Veneer - A thin (40 cm-1m) mantle of organic materials which generally conforms to the underlying topography. They may or may not be associated with discontinuous permafrost.

Appendix F

DETAILED SOIL DESCRIPTIONS OF TWO SELECTED PROFILES SAMPLED WITHIN THE STUDY AREA

Soil Symbol	Soil Name	Profile No.
IWO	Inwood	38
SLN	Selina	39

Profile descriptions have been computer generated from detailed sample sites and analytical information stored in the Canada Soil Information System (CanSIS) data bank.

NOV 08, 1984

IND MANITOBA 1983 PROFILE NO. 38

IDENTIFICATION: SURVEYED BY GP, FOR THE PURPOSE OF DETAILED SURVEY; PROVINCIAL SOIL SURVEY, WINNIPEG,MAN. STATUS: MODAL.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: GLEYED DARK GRAY. MINERAL SOIL FAMILY: LOAMY AND FINE LOAMY, CARBONATIC, ALKALINE, STRONGLY CALCAREOUS, COOL, SUBHUMID. SOIL MAP UNIT: TAXONOMIC SERIES, NOTATION: IND, ASSOCIATED SOILS: LURAND MCB. SOIL PHASES: VERY GENTLY SLOPING AND MODERATELY STONY.

LOCATION: MILITARY GRID REF. 14 UPL 2325 9495; NTS MAP AREA 62I 6; SE 33 17 2 E.

VEGETATION: HAZEL, ASPEN, GRASSES.

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, FINE LOAMY AND FINE SILTY (18 TO 35% CLAY), MODERATELY TO VERY STRONGLY CALCAREOUS (6-40% CACO3), MORAINAL (TILL), MIXED AND LIMESTONE; LANDFORM CLASSIFICATION: MORAINAL, COBBLY AND LOAMY, UNDULATING; SLOPE: CLASS 2 (0.5-2%) AND CLASS 3 (2-5%), FACING LEVEL, SITE AT UPPER SLOPE POSITION, LEVEL MICROTOPOGRAPHY,; SOIL MOISTURE AND DRAINAGE: SUBHUMID, IMPERFECTLY DRAINED, SLOWLY PERVIOUS, MODERATE SURFACE RUNOFF; MODERATELY STONY; PRESENT LAND USE: IMPROVED PASTURE,FORAGE.

SPECIAL NOTES: ALFALFA- GRASS FIELD.POCKETS AND LENSES OF S&G WITHIN THE TILL

LFH: 3 TO 0 CM, RANGE 2 TO 3 CM; HORIZON MOIST; CRUSHED MOIST 10YR 2/1.5; MATERIAL COMPOSITION SLIGHT DECOMPOSITION; PLENTIFUL, VERY FINE AND FINE, RANDOM ROOTS; SMOOTH, CLEAR HORIZON BOUNDARY.

AHE: 0 TO 11 CM, RANGE 8 TO 11 CM; HORIZON MOIST; CRUSHED MOIST 10YR 3/2; LOAM; WEAK TO MODERATE, FINE, SUBANGULAR BLOCKY STRUCTURE PSEUDO; MODERATE, FINE TO MEDIUM, GRANULAR SECONDARY STRUCTURE; LOOSE AND VERY FRIABLE CONSISTENCE; PLENTIFUL, VERY FINE AND FINE, RANDOM ROOTS; HIGHLY POROUS; WAVY, CLEAR HORIZON BOUNDARY.

BTGJ: 11 TO 22 CM, RANGE 8 TO 12 CM; HORIZON MOIST; CRUSHED MOIST 10YR 3/3; CLAY LOAM; MODERATE TO STRONG, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE PSEUDO; MODERATE TO STRONG, FINE TO MEDIUM, GRANULAR SECONDARY STRUCTURE; FIRM, PLASTIC CONSISTENCE; FEW, VERY FINE AND FINE, RANDOM ROOTS; MODERATELY POROUS; COMMON, VERY THIN AND THIN CLAY FILMS ON PED FACES-UNSPECIFIED; WAVY, CLEAR HORIZON BOUNDARY.

CKGJ: 22 TO 100 CM; HORIZON MOIST; CRUSHED MOIST 2.5Y 5.5/4; LOAM; FEW AND COMMON, MEDIUM, DISTINCT, 5YR 4/6 MOTTLES; MODERATE TO STRONG, FINE TO MEDIUM, PLATY STRUCTURE PSEUDO; MODERATE, FINE TO MEDIUM, GRANULAR SECONDARY STRUCTURE; FRIABLE, SLIGHTLY PLASTIC CONSISTENCE; WEAKLY CEMENTED AND STRONGLY CEMENTEDBY LIME; FEW, VERY FINE AND FINE, RANDOM ROOTS; SLIGHTLY POROUS AND MODERATELY POROUS; LIME AND IRON-MANGANESE CONCRETIONS LOCATED ; MODERATE AND STRONG EFFERVESCENCE; STRONGLY CALCAREOUS AND VERY STRONGLY CALCAREOUS; HOMOGENEOUS ; 20% GRAVELLY AND ANGULAR GRAVELLY COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

								C.E.C. (ME/100G)		EXCHANGEABLE CATIONS BUFFERED (ME/100G)			
HORIZON	PH 1	ORG C (%)	TOTAL N (%)	CALC CARB EQU.%	CAL-CITE (%)	DOLO-MITE (%)	EXTR ACID	BUFF.	PERM. CHARG	CA	MG	NA	K
LFH	7.3	14.89	0.66	7.1	0.7	5.9	4.4	57.0		37.8	11.8	0.1	0.5
AHE	7.1	11.56	0.42				4.2	40.6		27.5	7.0	0.1	0.2
BTGJ	7.2	1.20	0.10	1.3	0.4	0.8	2.7	36.9		25.1	7.8	0.1	0.8
CKGJ	7.9	0.49		52.8	19.9	30.3		12.5		23.9	7.4	0.1	0.2

IWO MANITOBA 1983 PROFILE NO. 38

CHEMICAL DATA (SURVEY)

HORIZON	ELEC COND (MMHOS/CM)	% H2O AT SATUR
LFH	0.8	159.6
AHE	0.6	80.6
BTGJ	0.3	62.5
CKGJ	0.4	38.0

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

	% PASSING				% OF SAMPLE									
HORIZON	3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
LFH														
AHE					1	4	7	27	12	51		34	15	
BTGJ				98	2	4	7	21	10	44		22	34	
CKGJ		99	95	93	2	4	5	8	9	28		45	27	

PHYSICAL DATA

ENGINEERING

HORIZON	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LFH								
AHE								
BTGJ	20.0	46.0	18.0		2.0	20.0	76	10
CKGJ	14.0	28.0	15.0		2.0	16.0	60	10

NOV 08, 1984

SLN MANITOBA 1983 PROFILE NO. 39

IDENTIFICATION: SURVEYED BY GP, FOR THE PURPOSE OF DETAILED SURVEY; PROVINCIAL SOIL SURVEY, WINNIPEG,MAN. STATUS: MODAL.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: GLEYED DARK GRAY LUVISOL. MINERAL SOIL FAMILY: SANDY/LOAMY, CARBONATIC AND MIXED NONCLAY, ALKALINE, STRONGLY CALCAREOUS, COOL, SUBHUMID. SOIL MAP UNIT: TAXONOMIC SERIES, NOTATION: ASSOCIATED SOILS: PLN. SOIL PHASES: LEVEL AND SLIGHTLY STONY AND NONROCKY.

LOCATION: MILITARY GRID REF. 14 UPM 2702 1060; NTS MAP AREA 62I 11; NW 13 19 2 E.

VEGETATION: GRASSES,FORBES AND SHRUBS, REGENERATING. ASPEN, GRASSES,WILLOW, CLOVER, ROSEBUSH.

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, COARSE LOAMY AND COARSE SILTY (<18% CLAY) AND SANDY, MODERATELY TO VERY STRONGLY CALCAREOUS (6-40% CACO3), LACUSTRINE, MIXED; PARENT MATERIAL 2: WEAK CHEMICAL WEATHERING, FINE LOAMY AND FINE SILTY (18 TO 35% CLAY), MODERATELY TO VERY STRONGLY CALCAREOUS (6-40% CACO3), LACUSTRO-TILL AND MORAINAL (TILL), MIXED AND LIMESTONE; LANDFORM CLASSIFICATION: FLUVIAL AND LACUSTRINE, LOAMY AND SANDY, LEVEL; SLOPE: CLASS 2 (0.5-2%), FACING LEVEL, SITE AT MIDDLE POSITION, LEVEL MICROTOPOGRAPHY,; SOIL MOISTURE AND DRAINAGE: SUBHUMID, IMPERFECTLY DRAINED, MODERATELY PERVIOUS, MODERATE AND SLOW SURFACE RUNOFF, PERCHED WATERTABLE; SLIGHTLY STONY; NONROCKY; PRESENT LAND USE: CROPLAND AND IMPROVED PASTURE,FORAGE, DITCH DRAINED.

SPECIAL NOTES: EDGE OF FIELD.POSSIBLY WOOD MORE G.D.G.

AH: 0 TO 12 CM, RANGE 8 TO 12 CM; HORIZON DRY; MATRIX DRY 10YR 3.5/2; FINE SANDY LOAM AND LOAM; WEAK, FINE TO MEDIUM, ANGULAR BLOCKY STRUCTURE PSEUDO; WEAK TO MODERATE, FINE, GRANULAR SECONDARY STRUCTURE PSEUDO; SOFT CONSISTENCE; FEW, VERY FINE AND FINE, VERTICAL AND HORIZONTAL ROOTS; MODERATELY POROUS; WAVY, CLEAR HORIZON BOUNDARY.

AE: 12 TO 20 CM, RANGE 6 TO 9 CM; HORIZON DRY; MATRIX DRY 10YR 6/2; LOAM; MODERATE, FINE TO MEDIUM, PLATY STRUCTURE PSEUDO; STRUCTURELESS, SINGLE GRAIN SECONDARY STRUCTURE PSEUDO; SLIGHTLY HARD CONSISTENCE; FEW, VERY FINE AND FINE, VERTICAL ROOTS; MODERATELY POROUS; WAVY, CLEAR HORIZON BOUNDARY.

BTGJ: 20 TO 30 CM, RANGE 8 TO 12 CM; HORIZON DRY; MATRIX DRY 2.5Y 4.5/4; SANDY CLAY LOAM; FEW, FINE, DISTINCT AND PROMINENT, 10YR 4/6 MOTTLES; MODERATE TO STRONG, MEDIUM, ANGULAR BLOCKY STRUCTURE PSEUDO; MODERATE, FINE TO MEDIUM, GRANULAR SECONDARY STRUCTURE PSEUDO; HARD, PLASTIC AND VERY PLASTIC CONSISTENCE; FEW, VERY FINE AND FINE, VERTICAL ROOTS; SLIGHTLY POROUS AND MODERATELY POROUS; COMMON, THIN CLAY FILMS ON PED FACES-UNSPECIFIED AND VISIBLE BRIDGES BETWEEN SAND GRAINS; WAVY, CLEAR HORIZON BOUNDARY.

CKGJ: 30 TO 60 CM, RANGE 20 TO 35 CM; HORIZON DRY; MATRIX DRY 2.5Y 6.5/4; FINE SAND AND VERY FINE SANDL.COMMON, MEDIUM, DISTINCT AND PROMINENT, 10YR 4/6 MOTTLES; STRUCTURELESS, SINGLE GRAIN STRUCTURE PSEUDO; PSEUDO; LOOSE CONSISTENCE; MODERATELY POROUS AND HIGHLY POROUS; MODERATE EFFERVESCENCE; STRONGLY CALCAREOUS; HOMOGENEOUS ; WAVY, GRADUAL HORIZON BOUNDARY.

2CKGJ: 60 TO 100 CM; HORIZON DRY; MATRIX DRY 2.5Y 7.5/2; SILT LOAM AND SILTY CLAY LOAM; FEW, FINE, FAINT AND DISTINCT MOTTLES; MODERATE, FINE TO MEDIUM, PLATY STRUCTURE PSEUDO; MODERATE, MEDIUM, ANGULAR BLOCKY SECONDARY STRUCTURE PSEUDO; HARD, SLIGHTLY PLASTIC CONSISTENCE; WEAKLY CEMENTED AND STRONGLY CEMENTEDBY LIME; SLIGHTLY POROUS; COMMON, FINE AND MEDIUM, SPHERICAL LIME CONCRETIONS LOCATED LOCAL CONCENTRATIONS ; STRONG EFFERVESCENCE; VERY STRONGLY CALCAREOUS AND EXTREMELY CALCAREOUS; HOMOGENEOUS ; 20% AND 30% GRAVELLY COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	TOTAL N (%)	CALC CARB EQU.%	CAL-CITE (%)	DOLO-MITE (%)	EXTR ACID	C.E.C. (ME/100G) BUFF.	C.E.C. (ME/100G) PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
AH	7.1	11.19	0.41				4.6	44.9		28.4	7.4	0.1	0.5
AE	7.2	0.44	0.08				1.8	11.2		6.1	1.9		0.1
BTGJ	7.3	0.58	0.06				2.6	21.8		13.0	4.6		0.3
CKGJ	7.7	0.06		7.3	0.2	6.6		5.1		8.7	1.5		0.1
2CKGJ	7.9			33.7	3.5	27.9		3.2		17.3	1.8		
				61.4	15.8	40.8							

CHEMICAL DATA (SURVEY)

HORIZON	ELEC COND (MMHOS/CM)	% H2O AT SATUR
AH	0.5	101.4
AE	0.2	35.8
BTGJ	0.2	46.7
CKGJ	0.6	28.8
2CKGJ	0.3	23.8

PHYSICAL DATA

ENGINEERING

HORIZON	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
AH								
AE								
BTGJ	19.0	31.0	19.0		1.8	13.0	60	10
CKGJ								
2CKGJ	13.0	15.0	13.0		2.1	7.0	40	09

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

HORIZON	% PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	% OF SAMPLE V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
AH						1	2	23	40	66		19	15	
AE						1	2	18	51	72		15	13	
BTGJ				98		1	1	13	50	65		13	22	
CKGJ						1	1	38	32	72		20	8	
2CKGJ		95	91	89		6	6	9	11	38		50	12	

```
@KEY

SEGMENT 11 :
     SAMPLE COLLECTION AND PREPARATION :
          FIELD SAMPLING = REPRESENTATIVE SITE
          SAMPLE PREPARATION = AIR DRY WITH GRINDING
     SIZE BASE FOR REPORTING (MM) =  2
     NUMBER OF SAMPLES =  7
     PH :
          PH VALUE 1 :
               SAMPLE STATE = AIR DRY
               METHOD = CALCIUM CHLORIDE
     ORGANIC CARBON = WET OXIDATION (WALKLEY-BLACK)
     TOTAL NITROGEN = MACRO-KJELDAHL, NO2 AND NO3 NOT INCLUDED
     CALCIUM CARBONATE EQUIVALENT = PRESSURE
     CALCITE AND DOLOMITE = PRESSURE
     EXTRACTABLE ACIDITY = BARIUM CHLORIDE-TRIETHANOLAMINE
     CATION EXCHANGE CAPACITY :
          BUFFERED = NH4AC, PH 7.0
     EXCHANGEABLE CATIONS :
          BUFFERED :
               METHOD USED = NH4AC, PH 7.0
               ANALYTICAL PROCEDURE = ATOMIC ABSORPTION
     ELECTRICAL CONDUCTIVITY :
          PASTE = SATURATED,MIXED
          INSTRUMENT = CONDUCTIVITY CELL-CUP
     WATER EXTRACT DETERMINATIONS :
          EXTRACT SOURCE = SATURATION EXTRACT
          REPORTING UNIT = ME/L
          EXTRACT DETERMINATIONS :
               CALCIUM = ATOMIC ABSORPTION
               MAGNESIUM = ATOMIC ABSORPTION
               SODIUM = ATOMIC ABSORPTION
               HCO3 = ACID TITRATION
               CL = POTENTIOMETRIC TITRATION
     PARTICLE SIZE ANALYSIS :
          PRETREATMENT REMOVAL OF = ORGANIC MATTER, SALTS
          DISPERSION = SODIUM HEXAMETAPHOSPHATE
          METHOD = PIPETTE
     WATER CONTENT AND RETENTION POROSITY :
          SAMPLING PREPARATION = GROUND AND SIEVED
          SAMPLE STATE = AIR DRY
          METHOD = PRESSURE MEMBRANE
     ATTERBERG LIMITS :
          PLASTIC LIMIT :
               SAMPLE STATE = AIR DRY
               METHOD = EVAPORATION
          LIQUID LIMIT :
               SAMPLE STATE = AIR DRY
               METHOD = EVAPORATION
     SHRINKAGE LIMIT :
          SAMPLE STATE = AIR DRY
          METHOD = EVAPORATION
```

Aasho Classification	
A-1	10
A-1-a	11
A-1-b	12
A-2	20
A-2-4	24
A-2-5	25
A-2-6	26
A-2-7	27
A-3	30
A-4	40
A-5	50
A-6	60
A-7	70
A-7-5	75
A-7-6	76
A-8	80

Unified Classification	
GW	01
GP	02
GM	03
GC	04
SW	05
SP	06
SM	07
SC	08
ML	09
CL	10
DL	11
MH	12
CH	13
OH	14
PT	15
CI	16
GM-GC	17
SM-SC	18
CL-ML	19

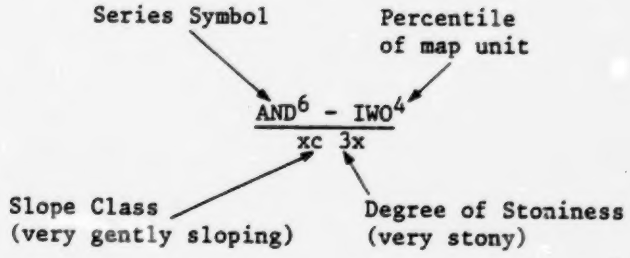
Soil Legend

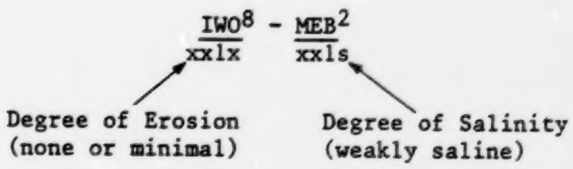
Soil Symbol	Soil Name	Surface Texture	Soil Drainage	Mode of Deposition	Family Particle Size	Subgroup
AND	Aneda	L	WELL	Till	Loamy	O.DG
BYD	Berry Island	FSL	POOR	Fluviolacustrine/Till	Sandy Skeletal/Loamy	R.H.GL
BVR	Beaverdam	LS	IMPER	Fluviolacustrine/Till	Sandy Skeletal/Loamy	GL.DG
CRN	Crane	MES	V.POOR	Organic	Mesic Peat	T.M
GHP	Glenhope	FSL	IMPER	Lacustrine/Till	Loamy	GLR.BL
GRH	Garrioch	LS	IMPER	Fluviolacustrine/Till	Sandy Skeletal/Loamy	GLR.BL
GUO	Gunton	LS	WELL	Fluviolacustrine/Till	Sandy Skeletal/Loamy	O.DG
IWO	Inwood	L	IMPER	Till	Loamy	GL.DG
LUR	Lundar	L	IMPER	Till	Loamy	GLR.BL
MEB	Meleb	L	POOR	Till	Loamy	R.HG
MHC	Marsh Complex	L	V.POOR	Organic	Textural Complex	R.G
PGE	Partridge Creek	C	POOR	Lacustrine/Till	Clayey/Loamy	R.HG
PGU	Peguis	C	IMPER	Lacustrine/Till	Clayey/Loamy	GL.DG
PIY	Piney	L	IMPER	Till	Loamy	GL.GL
PLN	Pelan	LFS	IMPER	Lacustrine/Till	Sandy/Loamy	GL.DG
SDB	Sand Beaches	S	IMP-WELL	Lacustrine	Sandy	O.R
SLN	Selina	LFS	IMPER	Lacustrine/Till	Sandy/Loamy	GLD.GL
SPG	Sprague	LFS	POOR	Lacustrine/Till	Sandy/Loamy	R.HG
STW	Stonewall	L	WELL	Till/Residual	Loamy	O.DG
ZZ	Water					

Appendix H

MAP UNIT SYMBOLOGY

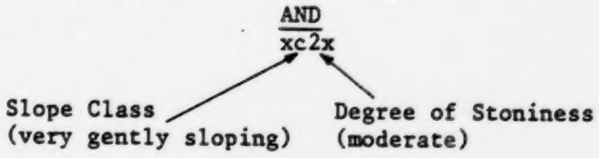
Compound Map Units

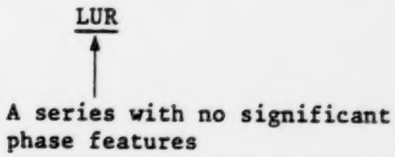

Series Symbol
Percentile of map unit
$\frac{\mathrm{AND}^6 - \mathrm{IWO}^4}{\mathrm{xc\ 3x}}$
Slope Class (very gently sloping)
Degree of Stoniness (very stony)


$\frac{\mathrm{IWO}^8}{\mathrm{xx1x}} - \frac{\mathrm{MEB}^2}{\mathrm{xx1s}}$
Degree of Erosion (none or minimal)
Degree of Salinity (weakly saline)

In a compound unit where two series share the same denominator, the phases apply to both series accordingly.

Simple Map Units


$\frac{\mathrm{AND}}{\mathrm{xc2x}}$
Slope Class (very gently sloping)
Degree of Stoniness (moderate)


$\frac{\mathrm{LUR}}{}$
A series with no significant phase features

Degree of Erosion

x	non-eroded or minimal
1	slightly eroded
2	moderately eroded
3	severely eroded
o	overblown

Stoniness

x	non-stony
1	slightly stony
2	moderately stony
3	very stony
4	exceedingly stony
5	excessively stony

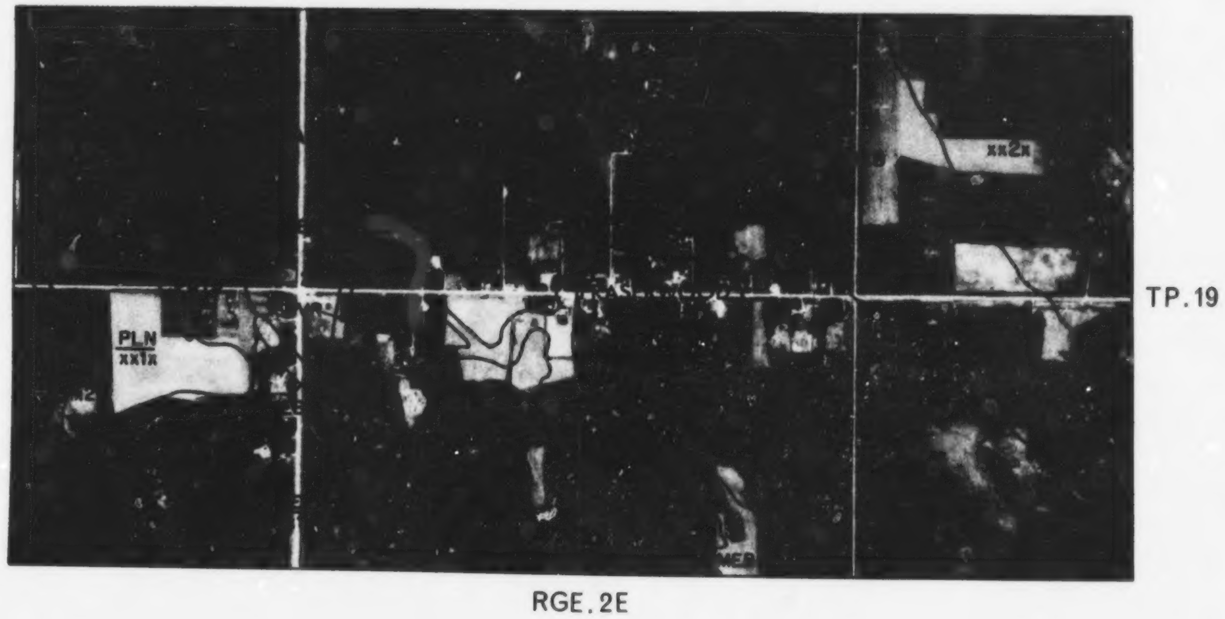
Slope Class

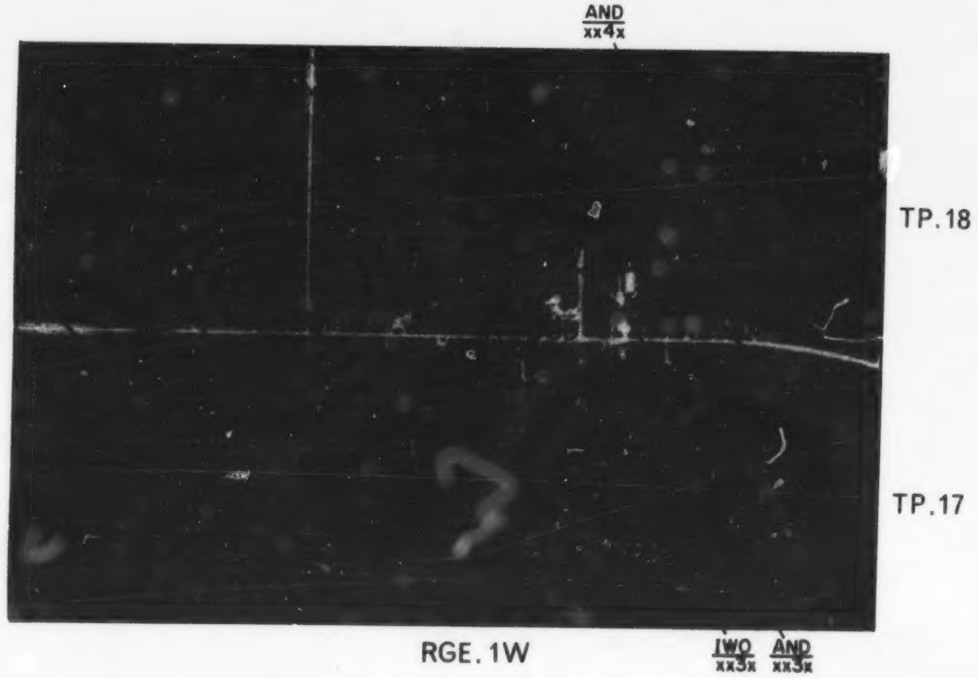
x	0-2% level to nearly level
c	2-5% very gently sloping
d	5-9% gently sloping
e	9-15% moderately sloping
f	15-30% strongly sloping
g	30-45% very strongly sloping
h	45-70% extremely sloping

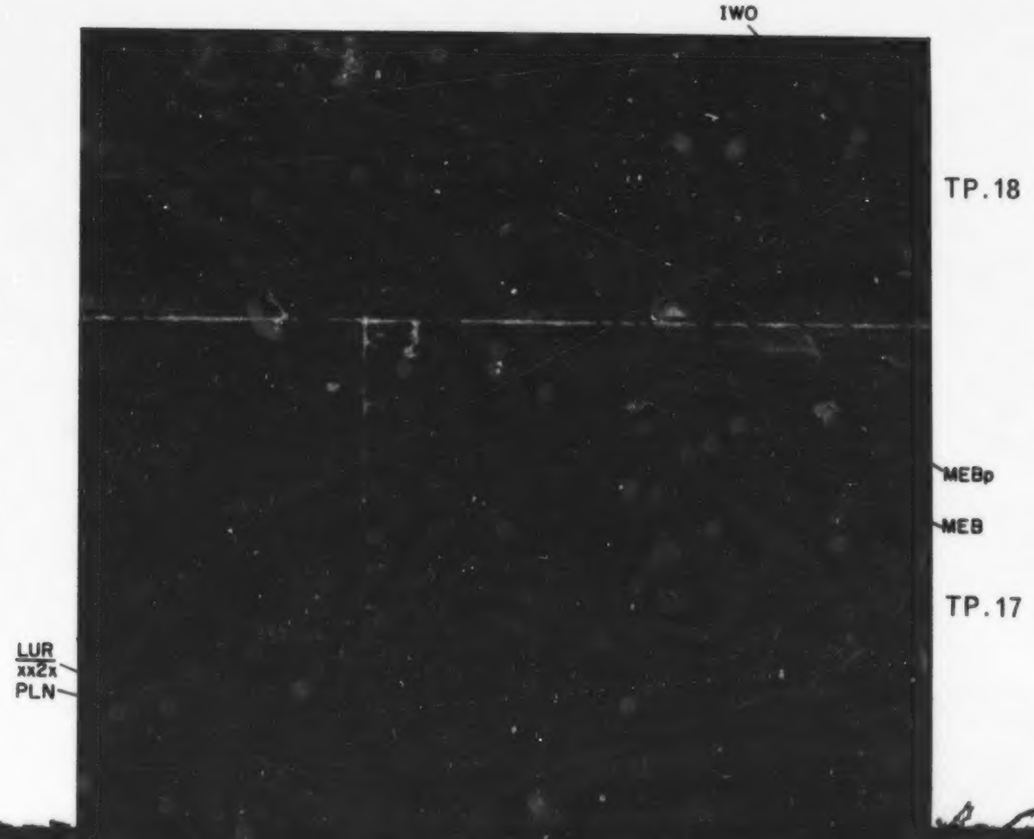
Degree of Salinity		Cond. ms/cm
x	non-saline	0-4
s	weakly saline	4-8
t	moderately saline	8-15
u	strongly saline	15+

SDBp = Sand Beach (peaty phase)

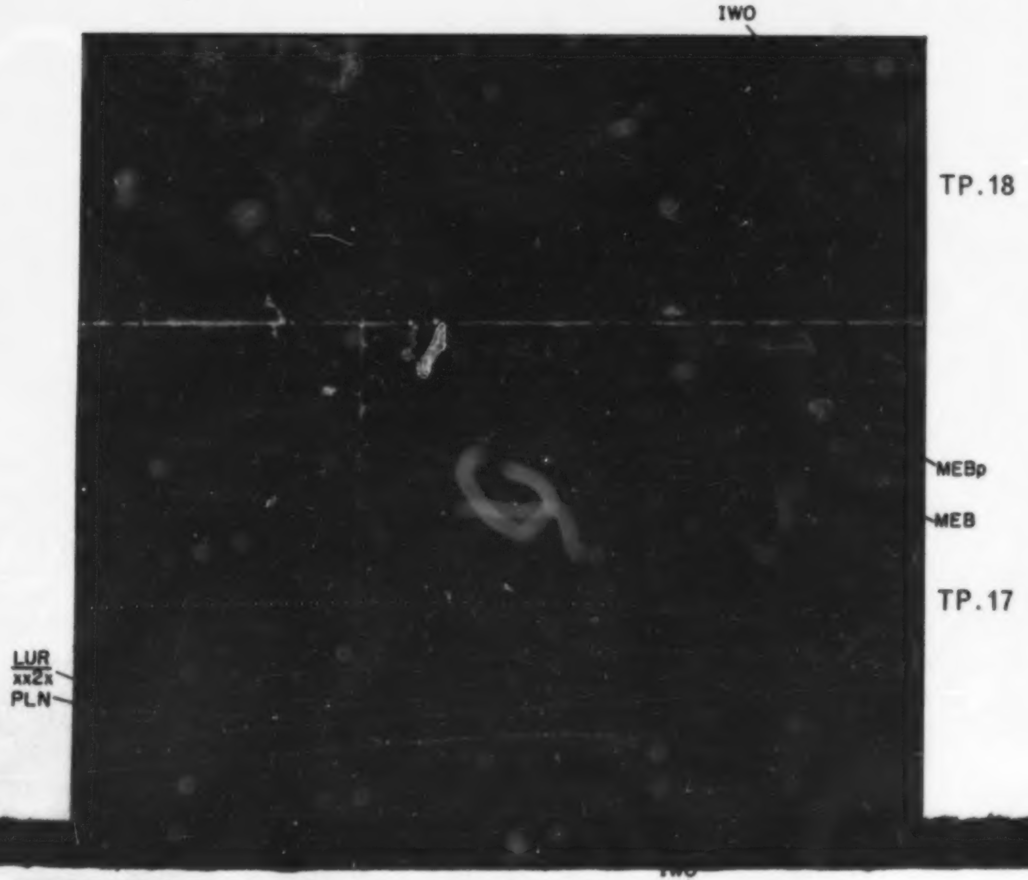
A STRIP


xx2x
TP.19
PLN
xx1x
MEB
RGE.2E


AND
xx4x
TP.18
TP.17
RGE.1W
IWO
xx3x
AND
xx3x


IWO
TP.18
MEBp
MEB
TP.17
LUR
xx2x
PLN

SOILS OF THE TOWNS OF INWOOD, KOMARNO, FRASERWOOD AND A STRIP ALONG THE LAKE MANITOBA SHORELINE, D57



1:20 000

0

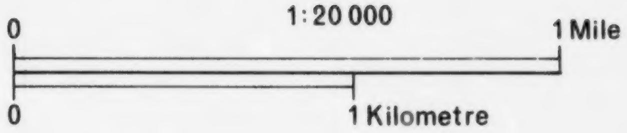
0 1 Kilo

N

SOIL LEGEN

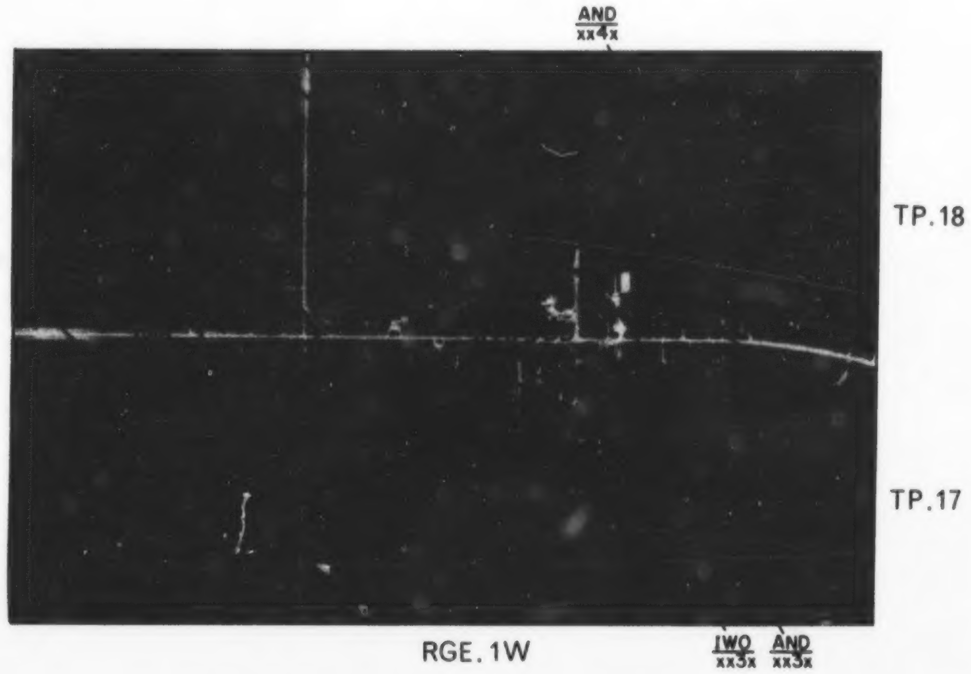
Soil Symbol	Soil Name	Surface Texture	Soil Drainage	Mode of
AND	Aneda	L	WELL	Till
BYD	Berry Island	FSL	POOR	Fluviolac
BVR	Beaverdam	LS	IMPER	Fluviolac
CRN	Crane	MES	V.POOR	Organic
GHP	Glenhope	FSL	IMPER	Lacustri
GRH	Garrioch	LS	IMPER	Fluviolac
GUO	Gunton	LS	WELL	Fluviolac
IWO	Inwood	L	IMPER	Till
LUR	Lundar	L	IMPER	Till
MEB	Meleb	L	POOR	Till
MHC	Marsh Complex	L	V.POOR	Organic
PGE	Partridge Creek	C	POOR	Lacustri

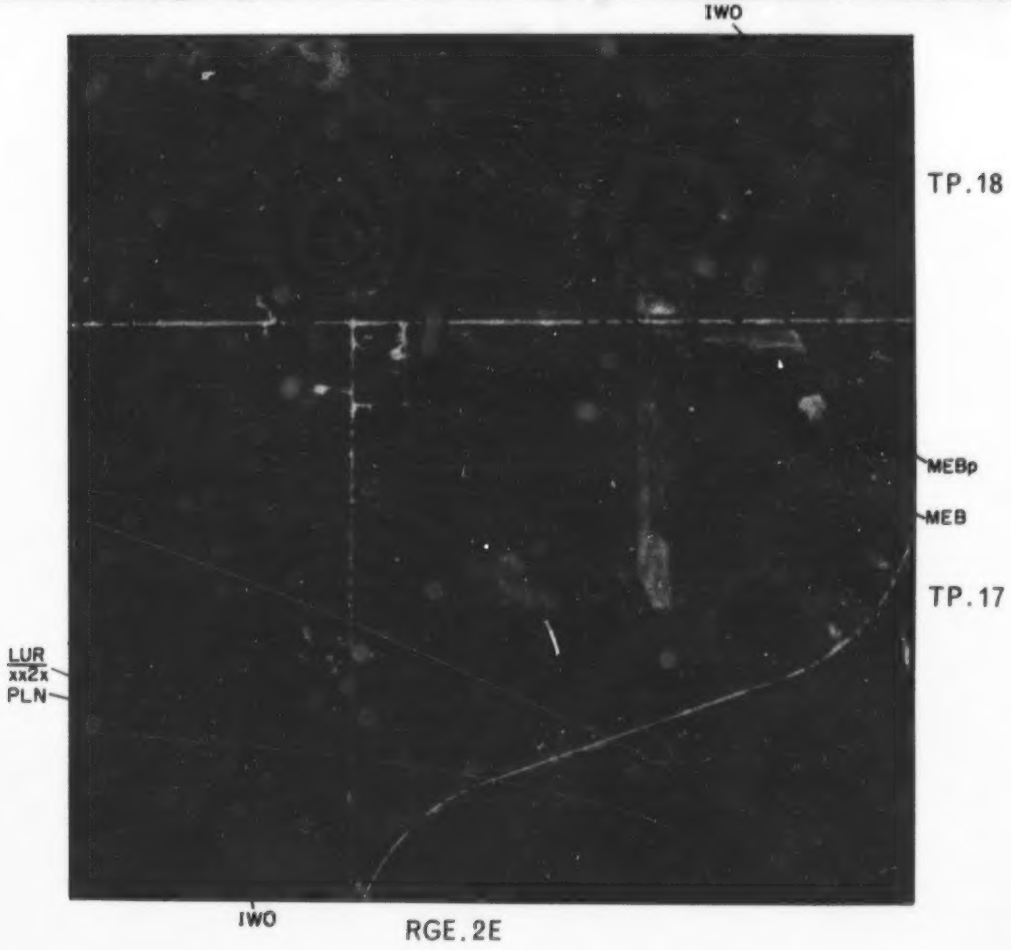
SOILS OF THE TOWNS OF
INWOOD, KOMARNO, FRASERWOOD AND
A STRIP ALONG THE LAKE MANITOBA SHORELINE, D57



SOIL LEGEND

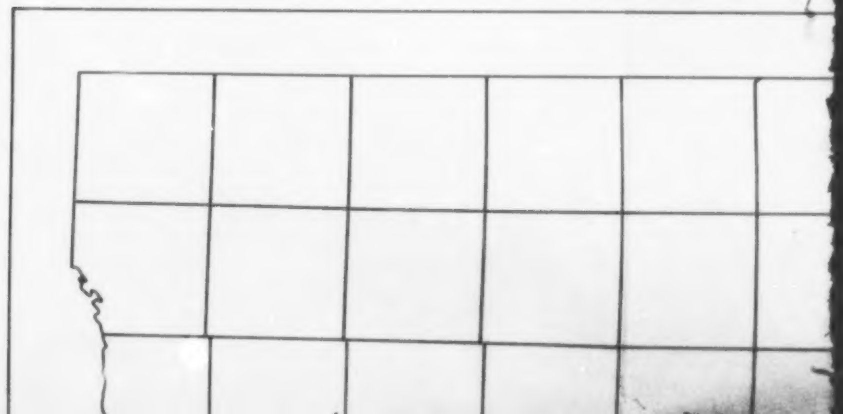
Soil Symbol	Soil Name	Surface Texture	Soil Drainage	Mode of Deposition	Family Particle Size	Subgroup
AND	Aneda	L	WELL	Till	Loamy	O.DG
BYD	Berry Island	FSL	POOR	Fluviolacustrine/Till	Sandy Skeletal/Loamy	R.H.GL
BVR	Beaverdam	LS	IMPER	Fluviolacustrine/Till	Sandy Skeletal/Loamy	GL.DG
CRN	Crane	MES	V.POOR	Organic	Mesic Peat	T.M
GHP	Glenhope	FSL	IMPER	Lacustrine/Till	Loamy	GLR.BL
GRH	Garrioch	LS	IMPER	Fluviolacustrine/Till	Sandy Skeletal/Loamy	GLR.BL
GUO	Gunton	LS	WELL	Fluviolacustrine/Till	Sandy Skeletal/Loamy	O.DG
IWO	Inwood	L	IMPER	Till	Loamy	GL.DG
LUR	Lundar	L	IMPER	Till	Loamy	GLR.BL
MEB	Meleb	L	POOR	Till	Loamy	R.HG
MHC	Marsh Complex	L	V.POOR	Organic	Textural Complex	R.G
PGE	Partridge Creek	C	POOR	Lacustrine/Till	Clayey/Loamy	R.HG

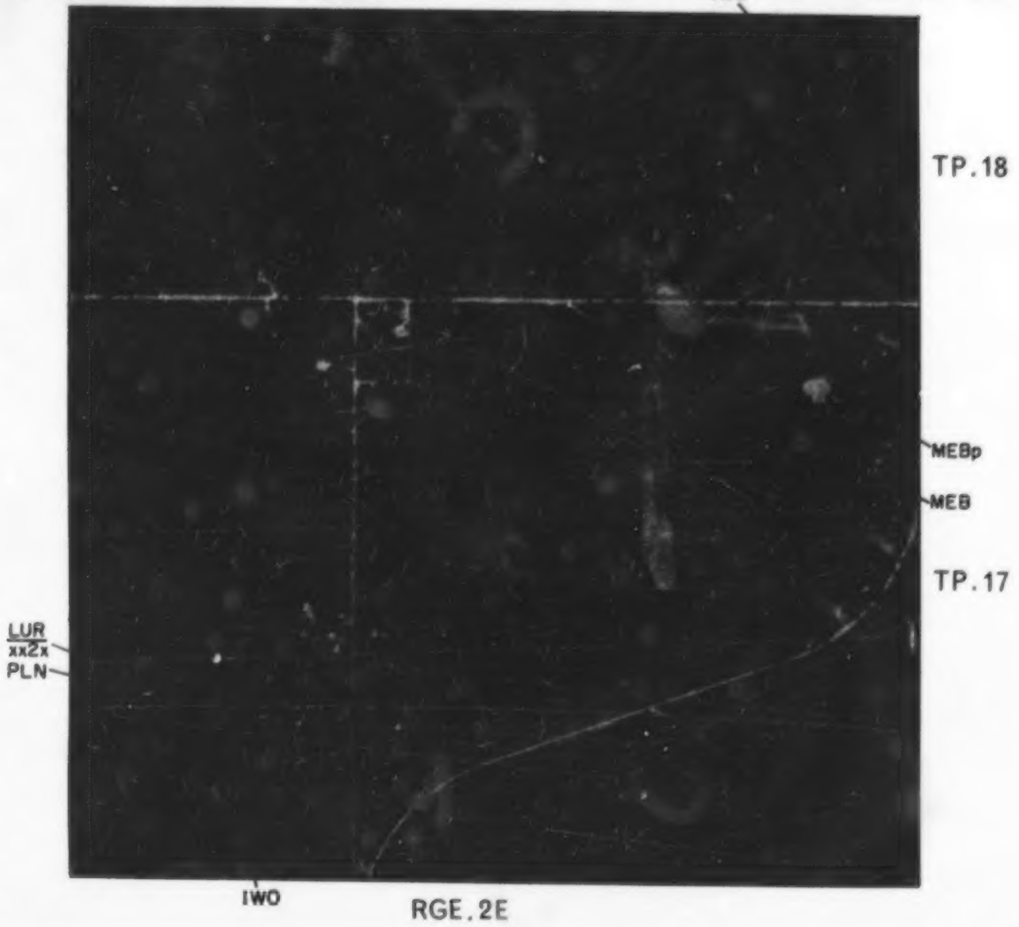

AND
xx4x
TP.18
TP.17
RGE.1W
IWO
xx3x
AND
xx3x


IWO
TP.18
MEBp
MEB
TP.17
LUR
xx2x
PLN
IWO
RGE.2E

LAKE MANITOBA

LOCATION OF STU

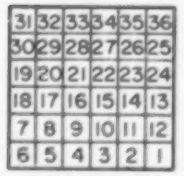



IWO
TP.18
MEBp
MEB
TP.17
LUR
xx2x
PLN
IWO
RGE.2E

0
0
1 Kilomet

SOIL LEGEND

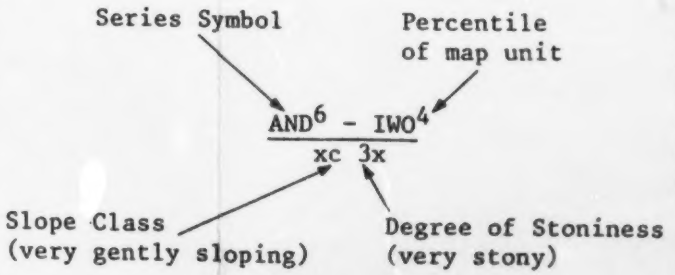
Soil Symbol	Soil Name	Surface Texture	Soil Drainage	Mode of Depos
AND	Aneda	L	WELL	Till
BYD	Berry Island	FSL	POOR	Fluviolacustr
BVR	Beaverdam	LS	IMPER	Fluviolacust
CRN	Crane	MES	V.POOR	Organic
GHP	Glenhope	FSL	IMPER	Lacustrine/Ti
GRH	Garrioch	LS	IMPER	Fluviolacustr
GUO	Gunton	LS	WELL	Fluviolacustr
IWO	Inwood	L	IMPER	Till
LUR	Lundar	L	IMPER	Till
MEB	Meleb	L	POOR	Till
MHC	Marsh Complex	L	V.POOR	Organic
PGE	Partridge Creek	C	POOR	Lacustrine/Ti
PGU	Peguis	C	IMPER	Lacustrine/Ti
PIY	Piney	L	IMPER	Till
PLN	Pelan	LFS	IMPER	Lacustrine/Ti
SDB	Sand Beaches	S	IMP-WELL	Lacustrine
SLN	Selina	LFS	IMPER	Lacustrine/Ti
SPG	Sprague	LFS	POOR	Lacustrine/Ti
STW	Stonewall	L	WELL	Till/Residual
ZZ	Water			


31 32 33 34 35 36
30 29 28 27 26 25
19 20 21 22 23 24
18 17 16 15 14 13
7 8 9 10 11 12
6 5 4 3 2 1

TOWNSHIP
DIAGRAM

MAP UNIT SY

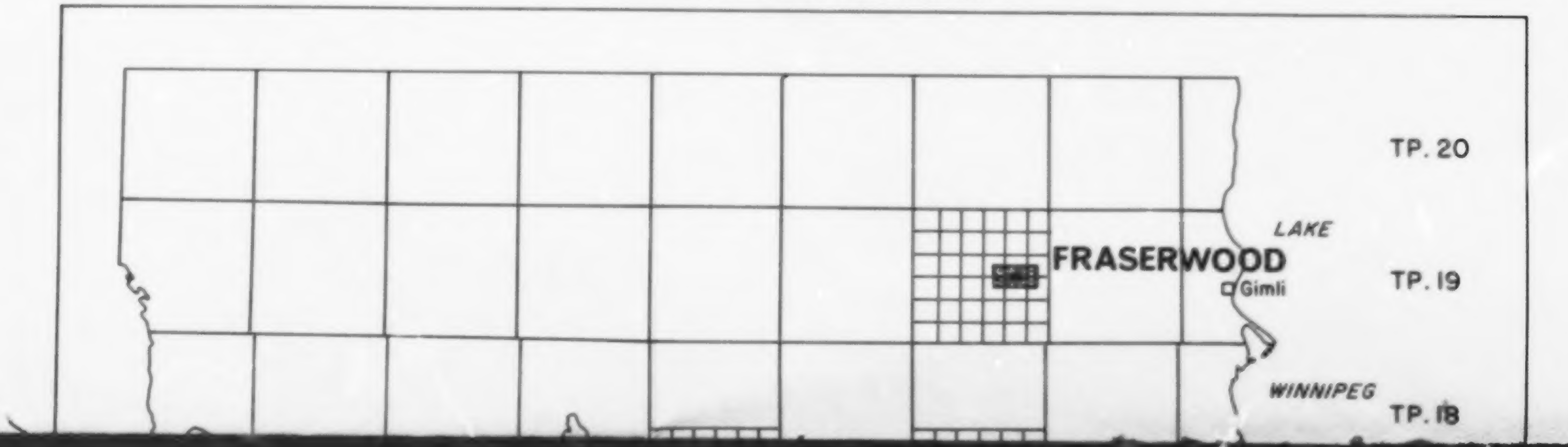
Compound Map

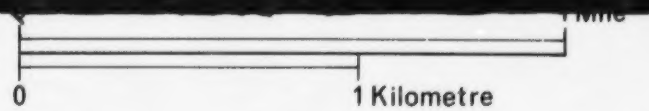

Series Symbol
Percentile
of map unit
AND6 - IWO4
xc 3x
Slope Class
(very gently sloping)
Degree of Stoniness
(very stony)

$$\frac{\text{AND}^{6} - \text{IWO}^{4}}{\text{xc}\ \ 3\text{x}}$$

In a compound unit where two series shar
phases apply to both series accordingly.

LOCATION OF STUDY AREAS


TP. 20
LAKE
FRASERWOOD
Gimli
TP. 19
WINNIPEG
TP. 18


0
1 Kilometre

SOIL LEGEND

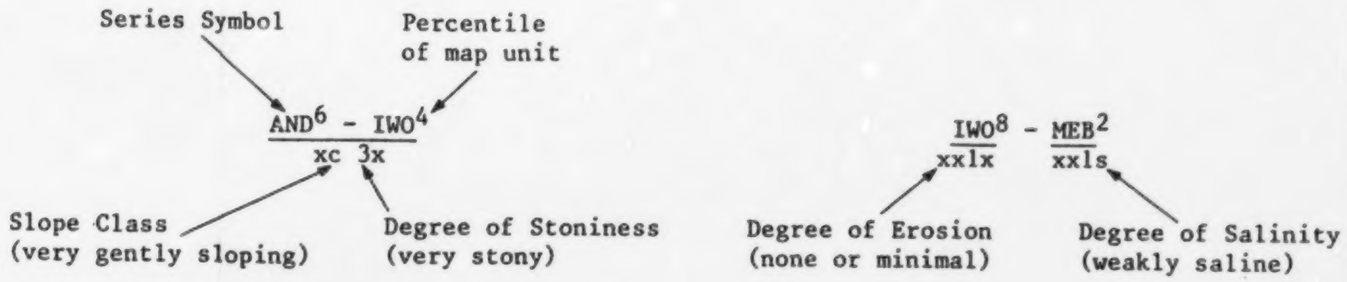
Soil Symbol	Soil Name	Surface Texture	Soil Drainage	Mode of Deposition	Family Particle Size	Subgroup
AND	Aneda	L	WELL	Till	Loamy	O.DG
BYD	Berry Island	FSL	POOR	Fluviolacustrine/Till	Sandy Skeletal/Loamy	R.H.GL
BVR	Beaverdam	LS	IMPER	Fluviolacustrine/Till	Sandy Skeletal/Loamy	GL.DG
CRN	Crane	MES	V.POOR	Organic	Mesic Peat	T.M
GHP	Glenhope	FSL	IMPER	Lacustrine/Till	Loamy	GLR.BL
GRH	Garrioch	LS	IMPER	Fluviolacustrine/Till	Sandy Skeletal/Loamy	GLR.BL
GUO	Gunton	LS	WELL	Fluviolacustrine/Till	Sandy Skeletal/Loamy	O.DG
IWO	Inwood	L	IMPER	Till	Loamy	GL.DG
LUR	Lundar	L	IMPER	Till	Loamy	GLR.BL
MEB	Meleb	L	POOR	Till	Loamy	R.HG
MHC	Marsh Complex	L	V.POOR	Organic	Textural Complex	R.G
PGE	Partridge Creek	C	POOR	Lacustrine/Till	Clayey/Loamy	R.HG
PGU	Peguis	C	IMPER	Lacustrine/Till	Clayey/Loamy	GL.DG
PIY	Piney	L	IMPER	Till	Loamy	GL.GL
PLN	Pelan	LFS	IMPER	Lacustrine/Till	Sandy/Loamy	GL.DG
SDB	Sand Beaches	S	IMP-WELL	Lacustrine	Sandy	O.R
SLN	Selina	LFS	IMPER	Lacustrine/Till	Sandy/Loamy	GLD.GL
SPG	Sprague	LFS	POOR	Lacustrine/Till	Sandy/Loamy	R.HG
STW	Stonewall	L	WELL	Till/Residual	Loamy	O.DG
ZZ	Water					

31	32	33	34	35	36
30	29	28	27	26	25
19	20	21	22	23	24
18	17	16	15	14	13
7	8	9	10	11	12
6	5	4	3	2	1

TOWNSHIP DIAGRAM

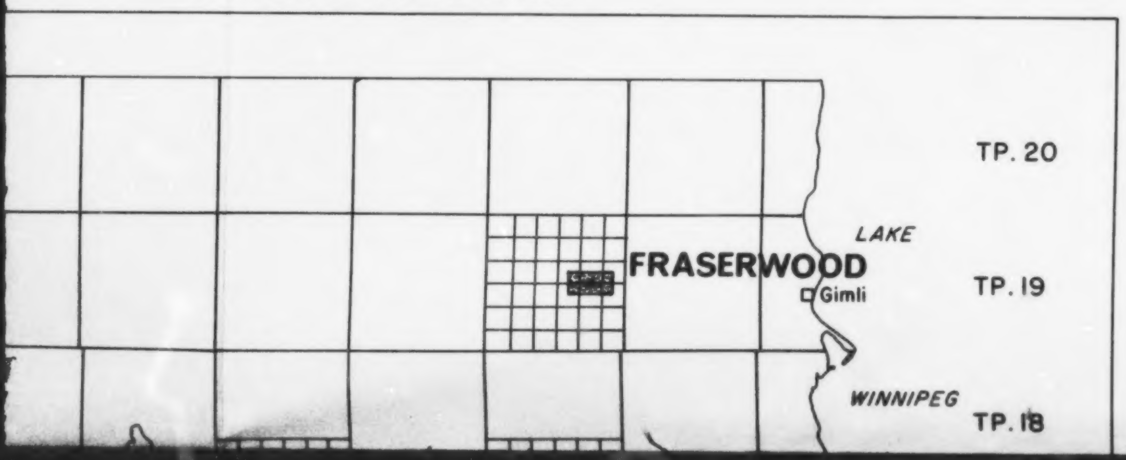
MAP UNIT SYMBOLOGY

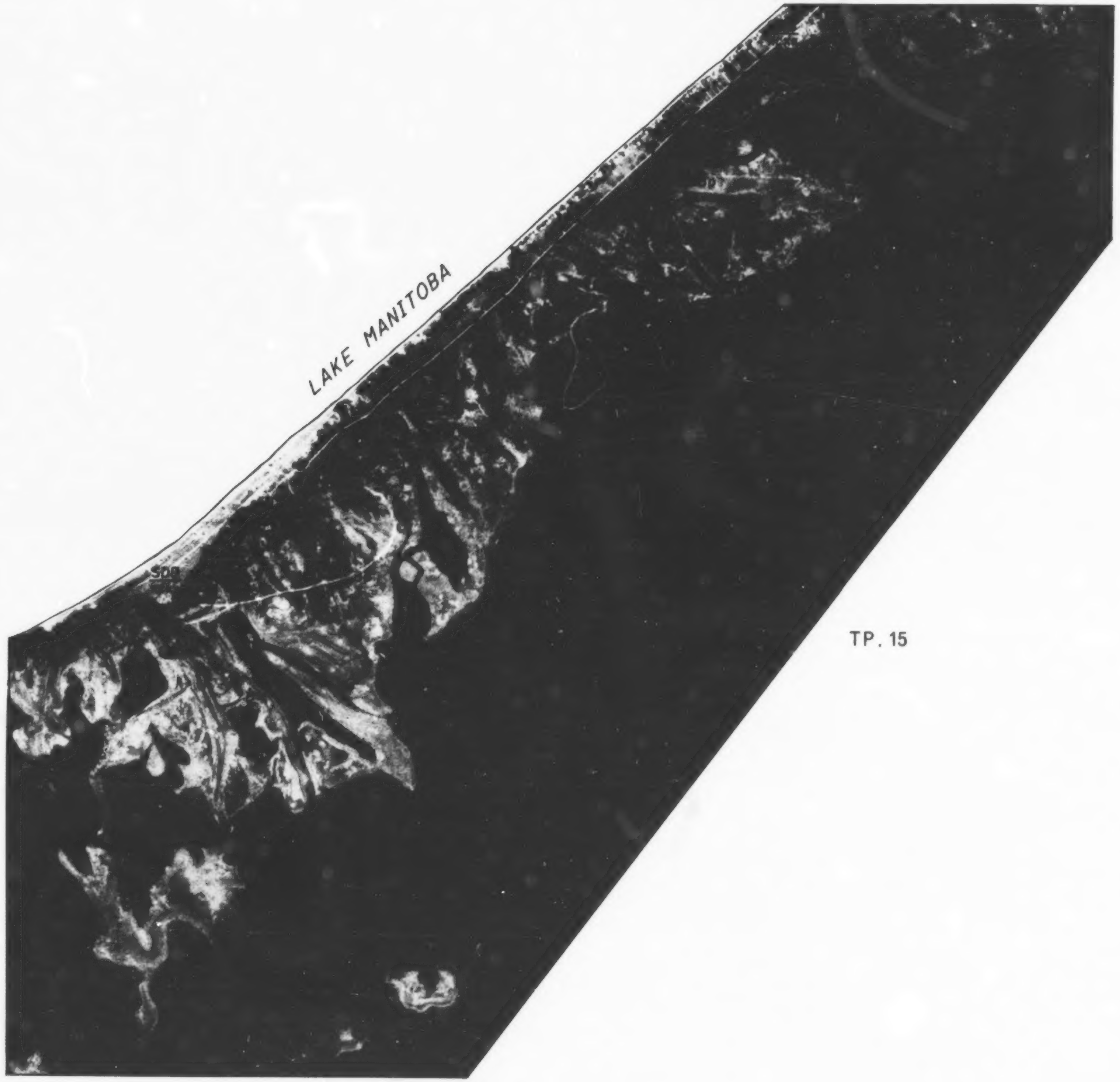
Compound Map Units


Series Symbol
Percentile of map unit
AND6 - IWO4
xc 3x
Slope Class (very gently sloping)
Degree of Stoniness (very stony)
IWO8 - MEB2
xx1x xx1s
Degree of Erosion (none or minimal)
Degree of Salinity (weakly saline)

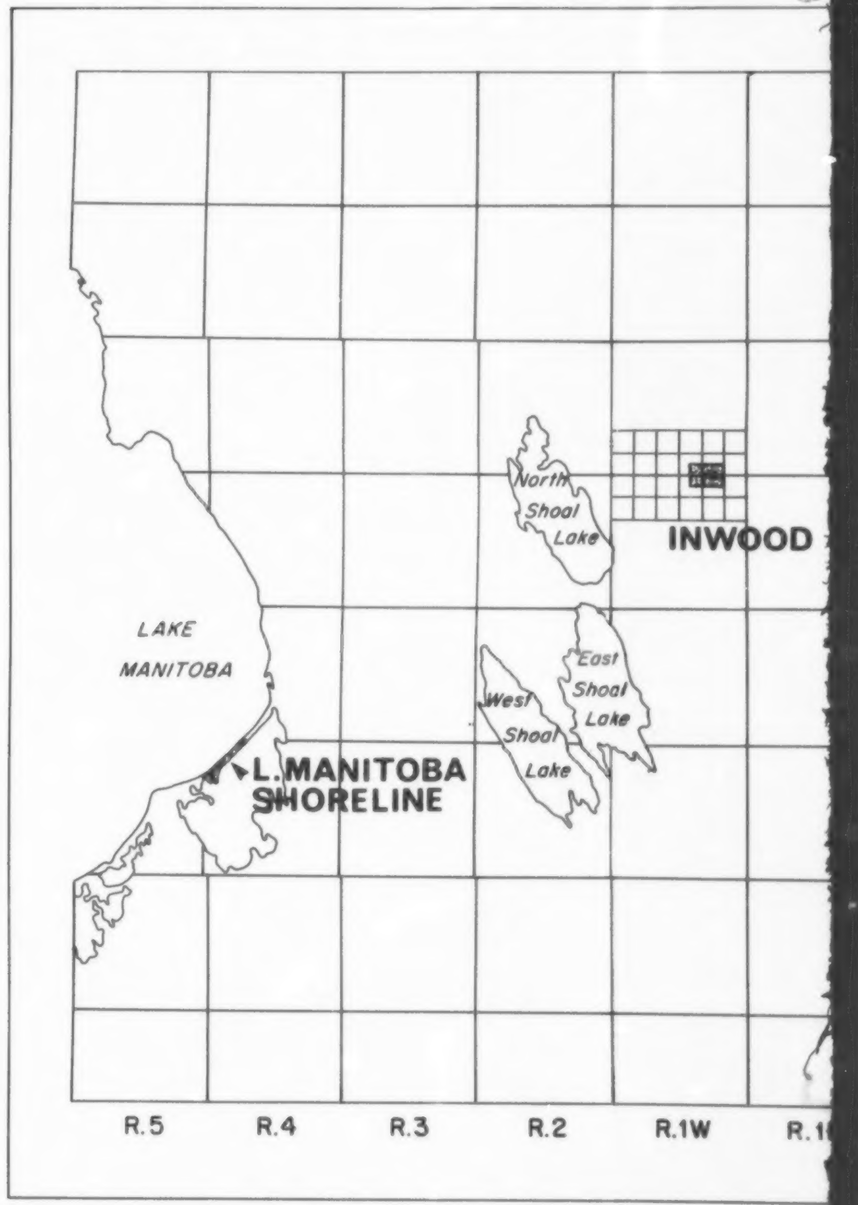
In a compound unit where two series share the same denominator, the phases apply to both series accordingly.

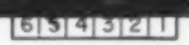
LOCATION OF STUDY AREAS


TP. 20
LAKE
FRASERWOOD
Gimli
TP. 19
WINNIPEG
TP. 18


LAKE MANITOBA
TP. 15
RGE. 4E

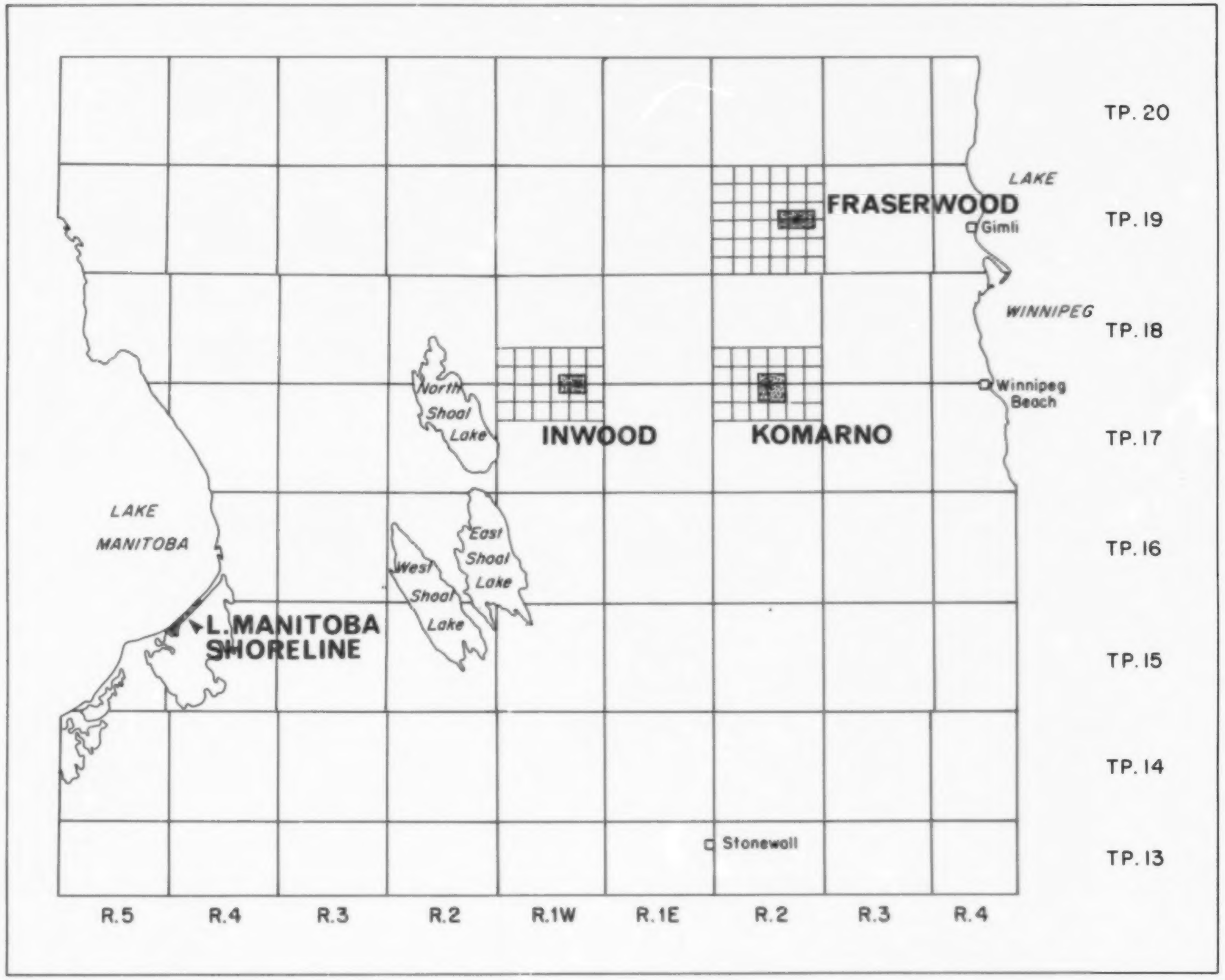
LOCATION OF STU


LAKE
MANITOBA
North
Shoal
Lake
INWOOD
East
Shoal
Lake
West
Shoal
Lake
L. MANITOBA
SHORELINE
R.5
R.4
R.3
R.2
R.1W
R.1



TOWNSHIP DIAGRAM

LOCATION OF STUDY AREAS


TP. 20
TP. 19
TP. 18
TP. 17
TP. 16
TP. 15
TP. 14
TP. 13
R.5
R.4
R.3
R.2
R.1W
R.1E
R.2
R.3
R.4
FRASERWOOD
INWOOD
KOMARNO
L. MANITOBA SHORELINE
LAKE MANITOBA
LAKE WINNIPEG
North Shoal Lake
East Shoal Lake
West Shoal Lake
Gimli
Winnipeg Beach
Stonewall

MAP U

Compou

Series Symbol

Percentile of map unit

$\frac{AND^6 - IWO^4}{xc\ 3x}$

Slope Class (very gently sloping)

Degree of Ston (very stony)

In a compound unit where two serie
phases apply to both series accord

Simpl

$\frac{AND}{xc2x}$

Slope Class (very gently sloping)

Degree of Stonin (moderate)

Degree of Erosion

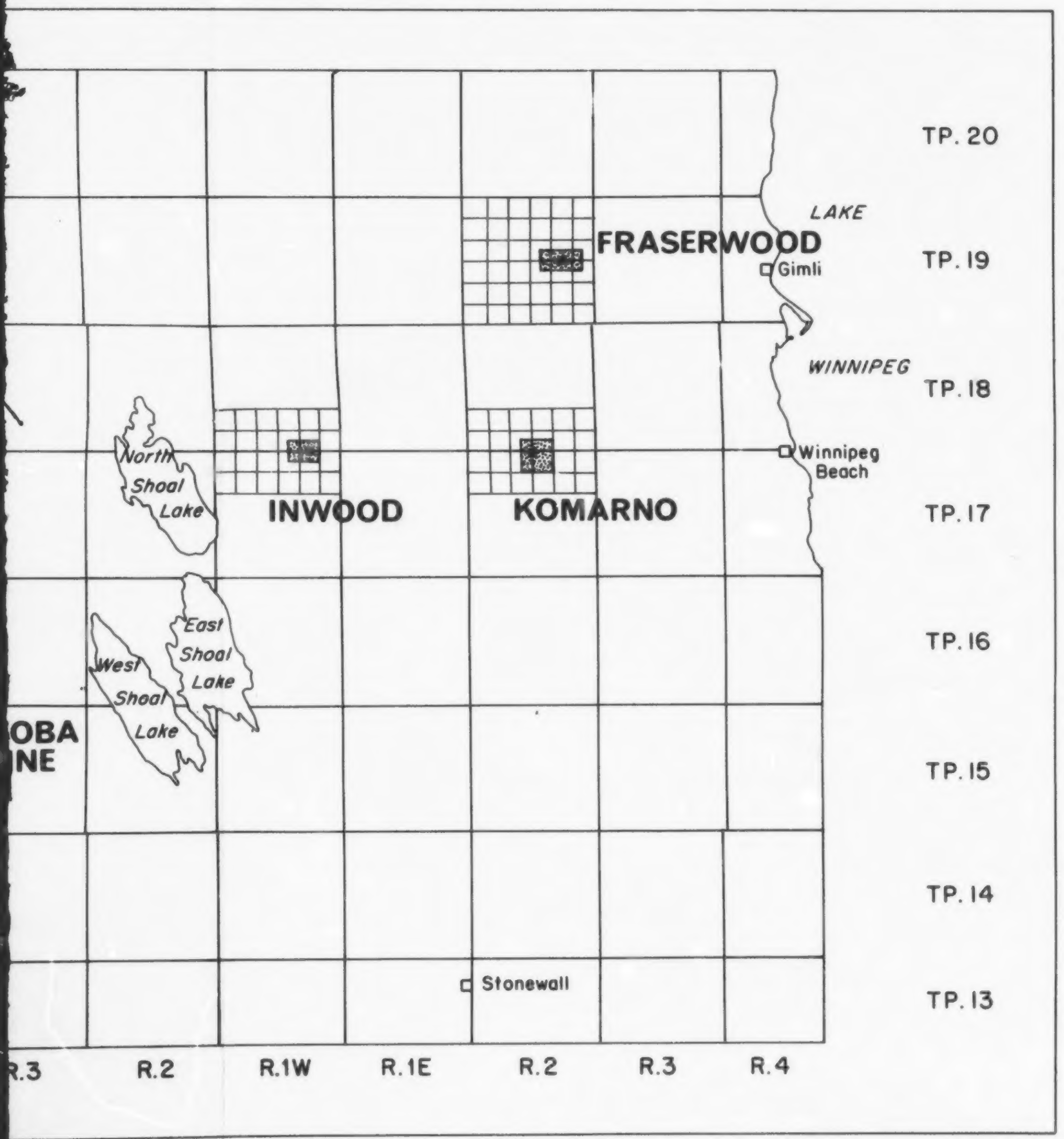
x	non-eroded or minimal
1	slightly eroded
2	moderately eroded
3	severely eroded
o	overblown

Slope Class

x	0-2% level to nearly level
c	2-5% very gently sloping
d	5-9% gently sloping
e	9-15% moderately sloping
f	15-30% strongly sloping
g	30-45% very strongly sloping
h	45-70% extremely sloping

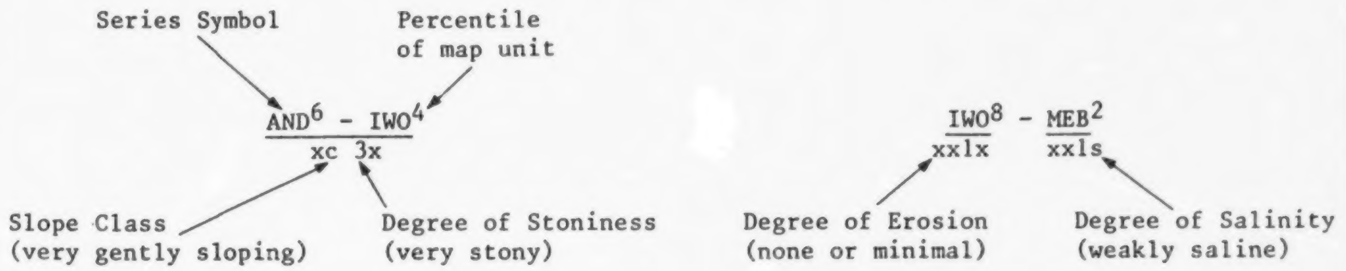
TOWNSHIP DIAGRAM

LOCATION OF STUDY AREAS


TP. 20
TP. 19
TP. 18
TP. 17
TP. 16
TP. 15
TP. 14
TP. 13
FRASERWOOD
INWOOD
KOMARNO
LAKE
WINNIPEG
Gimli
Winnipeg Beach
Stonewall
North Shoal Lake
East Shoal Lake
West Shoal Lake
OBA
NE
R.3
R.2
R.1W
R.1E
R.2
R.3
R.4

MAP UNIT SYMBOLOGY

Compound Map Units



Series Symbol

Percentile of map unit

$\frac{AND^6 - IWO^4}{xc\ 3x}$

$\frac{IWO^8 - MEB^2}{xx1x \quad xx1s}$

Slope Class (very gently sloping)

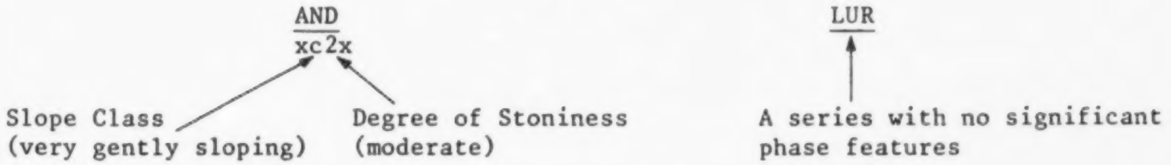
Degree of Stoniness (very stony)

Degree of Erosion (none or minimal)

Degree of Salinity (weakly saline)

In a compound unit where two series share the same denominator, the phases apply to both series accordingly.

Simple Map Units



$\frac{AND}{xc2x}$

$\frac{LUR}{}$

Slope Class (very gently sloping)

Degree of Stoniness (moderate)

A series with no significant phase features

Degree of Erosion

x	non-eroded or minimal
1	slightly eroded
2	moderately eroded
3	severely eroded
o	overblown

Slope Class

x	0-2% level to nearly level
c	2-5% very gently sloping
d	5-9% gently sloping
e	9-15% moderately sloping
f	15-30% strongly sloping
g	30-45% very strongly sloping
h	45-70% extremely sloping

Stoniness

x	non-stony
1	slightly stony
2	moderately stony
3	very stony
4	exceedingly stony
5	excessively stony

Degree of Salinity		Cond. ms/cm
x	non-saline	0-4
s	weakly saline	4-8
t	moderately saline	8-15
u	strongly saline	15+

CANADA MANITOBA SOIL SURVEY, 1986